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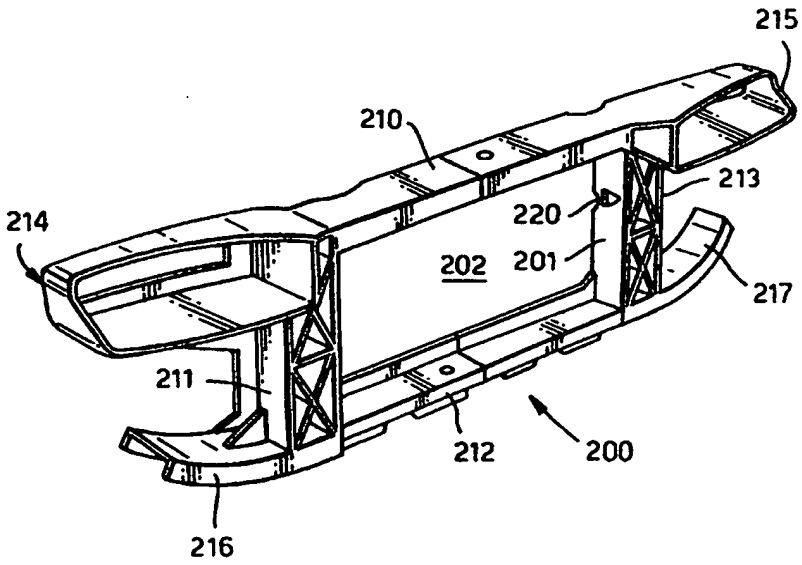
(54) Title: VEHICLE MODULE



(57) Abstract

A moulded plastics structure (200) for use in volume production of a vehicle in which the structure has an inner wall (201) defining an opening (202), the inner wall (201) having means for securing the structure (200) to a heat exchanger assembly, and also in which the structure (200) has opposing lateral extremities forming respective mountings for headlamps of the vehicle.

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VEHICLE MODULE

The present invention relates generally to volume production of vehicles, and more specifically to a structure and an assembly useful in such production.

Vehicle components such as headlamps, radiators, fan and shroud units are usually separately mounted on a vehicle during its manufacture. Some of the components may require alignment for correct operation, and access to the components may be restricted and difficult. This is both expensive and time consuming.

It is therefore an object of the present invention to at least partly mitigate these problems.

According to a first aspect of the present invention there is provided a moulded plastics structure for use in volume production of a vehicle, said structure comprising an inner wall defining an opening, the inner wall having means for securing said structure to a heat exchanger assembly, said structure having opposing lateral extremities forming respective mountings for headlamps of said vehicle.

Preferably the structure further comprises mountings for cleaning apparatus for cleaning said headlamps.

Conveniently the mountings for cleaning apparatus comprise mountings for a headlamp washer.

Advantageously the heat exchanger assembly comprises a fan shroud device secured to a vehicle radiator, said fan shroud device providing mountings for a cooling fan.

Conveniently the fan shroud device comprises liquid reservoirs.

According to a second aspect of the present invention there is provided a method for forming a moulded plastics structure in

accordance with the first aspect of the invention, comprising providing a mould corresponding to said structure and using a moulding process to form said structure.

Preferably the moulding process comprises blow moulding.

Alternatively, preferably the moulding process comprises injection moulding.

Advantageously the injection moulding process comprises thermoforming.

Alternatively, preferably the moulding process comprises rotational moulding.

According to a third aspect of the present invention there is provided an assembly for use in volume production of a vehicle, said assembly comprising a radiator, an air guide device and a headlamp mounting member, said air guide device being supported on said radiator and having a fan support for securing thereto a cooling fan, said headlamp mounting member having an internal wall defining an opening, and extending therefrom laterally to form respective opposed mountings for vehicle headlamps, said air guide device being disposed in said opening and secured to headlamp mounting member.

Preferably the headlamp mounting member further has mountings for cleaning apparatus and headlamps.

Advantageously said headlamp mounting member is made of moulded plastics material.

Conveniently said air guide device is formed by the fan shroud which has a body portion engaging said radiator, said body portion comprising a reservoir for cleaning fluid.

Preferably the headlamp mounting member includes securing

portions for securing the assembly to a vehicle.

An embodiment of the present invention will now be described hereinafter by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a moulded plastics structure for use in volume production of a vehicle in accordance with one aspect of the present invention.

Figure 2 shows an exploded partial front perspective view of a vehicle and vehicle parts to form an assembly in accordance with another aspect of the present invention.

Figure 3 shows an exploded front perspective view of a vehicle and an assembly in accordance with the present invention.

Figure 4 shows a front perspective view of a vehicle to which a vehicle assembly of Figure 2 has been secured.

In the drawings like reference numerals refer to like parts.

Referring to Figure 1, a moulded plastics structure 200 for use in volume production of a vehicle consists of four generally straight members 10-13 forming the perimeter of a rectangle such that the inner wall 201 of the four members defines a rectangular opening 202. One pair 210, 212 of mutually opposed members is longer than the respective pair 211, 213. In use, the longer pair 210, 212 are disposed substantially horizontally and the shorter 211, 213 are disposed substantially vertically. The opening 202 is dimensioned to receive a vehicle radiator assembly and the inner walls 201 of the two vertical members 211, 213 have sockets 220 for engagement with the radiator assembly.

Socket-defining members 214, 215 extend laterally outwardly from the top of the two shorter members 211, 213, the socket members forming mountings for headlamps and mountings for cleaning

apparatus for cleaning the headlamps. At the lower extremity of the shorter members 211, 213 there extend laterally outwardly upwardly curved members 216, 217.

To form the moulded plastics structure, a suitable mould is provided and a moulding technique is used. Preferred techniques include blow moulding, injection moulding (including thermoforming) and rotational moulding. Other suitable techniques include vacuum forming and compression moulding although any technique or combination of techniques is envisaged.

Referring to Figure 2, the moulded plastics structure consists of two substantially mirror-symmetrical parts 11, 12. Each of the parts 11, 12 has a respective one of the shorter members 211, 213 described with respect to Figure 1 and thus consists of a first rearwardly open-sided box member 120 which extends vertically as seen in the figure. The left hand part 11 has an upper open-sided box member 24 extending laterally and to the right from the top of its box member 120. The upper box member 24 is downwardly open. At the bottom of the box member 120 there is a lower support strip 23 having an upwardly extending flange 121 which extends parallel to the second box member. Also at the top of the first box member 120, but extending laterally in the opposite direction to the upper box member 24, a strip 21 extends to define a socket 122 which forms a mounting for a vehicle headlamp and a mounting for a headlamp washer nozzle. Extending from the bottom of the box member 120 there is an arm 27 which curves upwardly and outwardly.

As previously mentioned, the two parts 11 and 12 are substantially mirror-symmetrical with the exception of a tongue 25 protruding from the end of the upper box member 24, which co-operates with a hole 26 in the upper box member 24 of the second part 12 and a corresponding tongue 25 on the lower support strip 23 of the second part 12 which co-operates with a hole 26 in the corresponding strip of the first part 11.

When the parts 11, 12 are secured together by the tongues 25 and holes 26 the upper box members 24 and the lower support strip 23 form the opposed longer members 210, 212 described with respect to Figure 1. The inner wall 201 of the structure then defines the opening 202. The opening engages the outside periphery of a fan shroud structure, which may be of the type disclosed in US Patent No. 5649587 (McCord Winn Textron Inc). The shroud has a generally rectangular periphery defined by two generally vertical opposing side members 130, 131, whose length corresponds substantially to the length of the box members 120 of the two parts 11, 12 and a top member 132 whose length corresponds substantially to the spacing between the two first box members 120 when the two parts 11, 12 are assembled together. The top member 132 is such as to engage within the upper open box member 24 of the two parts 11, 12 and the shroud structure further has securing protrusions 134 extending outwardly from the side members 130, 131 to engage in sockets 135 of the first box members 120. At the front of the shroud structure 14, the side members and the top define an opening for engaging with the outer periphery of a vehicle radiator 16. At the rear of the shroud structure 14, the shroud structure forms an air guide device leading to a circular opening within which there is mounted a fan 13. The fan 13 is supported in the opening by a shroud cap 15 having plural support arms depending from a circumferential member.

Where the shroud structure 14 is of the type disclosed in US Patent No. 5649587, the side members and the top member define respective fluid reservoirs for storing fluid to be used for vehicle headlamp and windscreen washers. Such reservoirs are filled through respective filler caps 32, 33. The presence of the radiator in close proximity to the fluid reservoirs ensures that under normal operating conditions, the fluid contained in the reservoirs will not freeze.

The parts shown in Figure 2 are assembled as follows:-

The radiator 16 is disposed within the opening defined by the

side members 130, 131 and the top member 132 and the fan is mounted within its opening. The resulting sub-assembly is then disposed within the opening defined by the two parts 11, 12, with the top of the shroud structure 14 contained within the upper open-box structure 24 and the mounting protrusions 134 within the sockets 135. The two parts 11, 12 are urged towards one another and secured in place.

Once the assembly has been assembled together, a headlamp 17 is mounted in each of the sockets 122. The complete assembly is shown in Figure 3.

Referring now to Figure 3, the front portion of the vehicle 20 has a laterally-extended upper strip 50 which extends from one side of the front of the vehicle to the other. This member has a form which corresponds to the upper edge of the assembly. The vehicle also has two spaced vertically extending box members 52, 53 which correspond to the rearwardly-open box structures 120 of the two parts 11, 12. In use, the box structures 120 engage on the vertically-extending members 52, 53. The lower part of the vehicle front is defined by a generally horizontal and laterally-extending member 51 whose ends curve upwardly in conformity with the curve of the arms 27, 28 so that the lower support members 23 and the arms rest on the member 51.

Thus it will be understood by those skilled in the art that the laterally-extending members 50, 51 define a "socket" within which the assembly 10 can be received and supported; the vertically-extending members 52, 53 enable the assembly to be secured to the vehicle.

In this way the invention provides an assembly of vehicle parts which may be assembled prior to mounting to a vehicle and then mounted to the front of a vehicle relatively simply and inexpensively. Significantly, the alignment of the components can also be performed off the vehicle, and before mounting the assembly to the vehicle.

Although the present invention has been shown in respect of a car assembly it is envisaged that the invention could be adapted for use during the manufacture of any vehicle.

Likewise it is envisaged that various other vehicle components, for example indicator light clusters, could be included in the vehicle assembly.

CLAIMS:

1. A moulded plastics structure for use in volume production of a vehicle, said structure comprising an inner wall defining an opening, the inner wall having means for securing said structure to a heat exchanger assembly, said structure having opposing lateral extremities forming respective mountings for headlamps of said vehicle.

2. A moulded plastics structure according to claim 1 wherein the structure further comprises mountings for cleaning apparatus for cleaning said headlamps.

3. A moulded plastics structure according to claim 2 wherein the mountings for cleaning apparatus comprise mountings for a headlamp washer.

4. A moulded plastics structure according to any one of claims 1 to 3 wherein the heat exchanger assembly comprises a fan shroud device secured to a vehicle radiator, said fan shroud device providing mountings for a cooling fan.

5. A moulded plastics structure according to claim 4 wherein the fan shroud device comprises liquid reservoirs.

6. A method for forming a moulded plastics structure in according to claim 1 said method comprising providing a mould corresponding to said structure and using a moulding process to form said structure providing a mould corresponding to said structure and using a moulding process to form said structure.

7. A method according to claim 6 wherein the moulding process comprises blow moulding.

8. A method according to claim 6 wherein the moulding process comprises injection moulding.

9. A method according to claim 6 wherein the injection moulding process comprises thermoforming.

10. A method according to claim 6 wherein the moulding process comprises rotational moulding.

11. An assembly for use in volume production of a vehicle, said assembly comprising a radiator, an air guide device and a headlamp mounting member, said air guide device being supported on said radiator and having a fan support for securing thereto a cooling fan, said headlamp mounting member having an internal wall defining an opening, and extending therefrom laterally to form respective opposed mountings for vehicle headlamps, said air guide device being disposed in said opening and secured to headlamp mounting member.

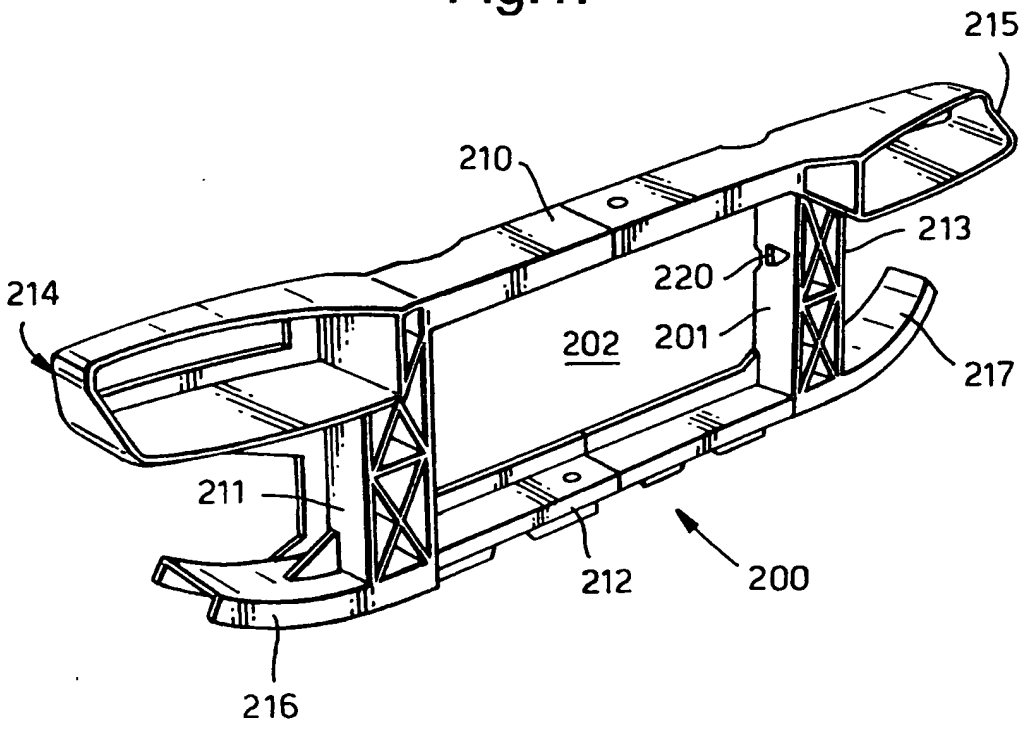
12. An assembly according to claim 11 wherein the headlamp mounting member further has mountings for cleaning apparatus and headlamps.

13. An assembly according to claim 11 or 12 wherein said headlamp mounting member is made of moulded plastics material.

14. An assembly according to any one of claims 11 to 13 wherein said air guide device is formed by the fan shroud which has a body portion engaging said radiator, said body portion comprising a reservoir for cleaning fluid.

15. As assembly according to any one of claims 11 to 14 wherein the headlamp mounting member includes securing portions for securing the assembly to a vehicle.

Fig.1.



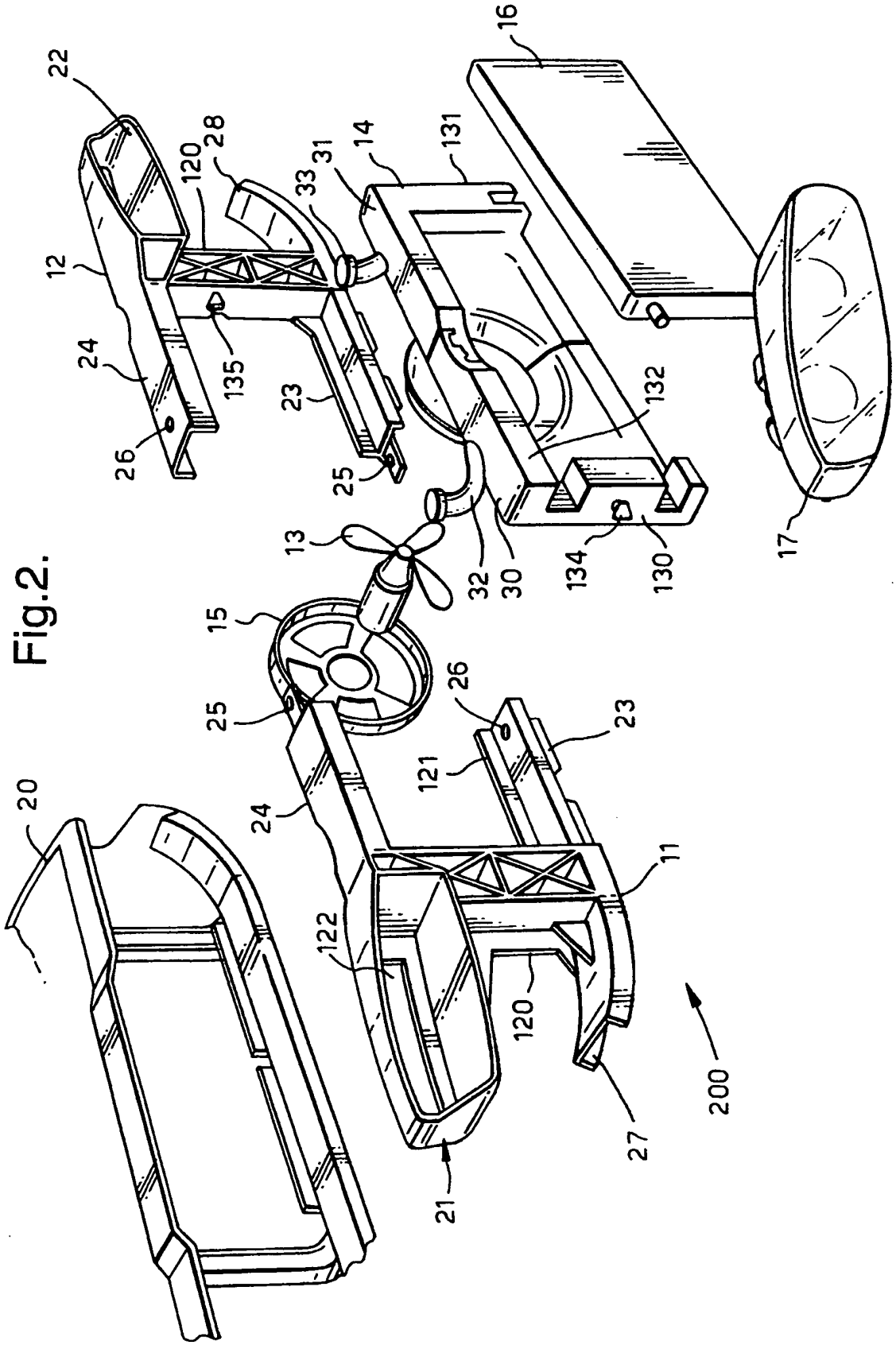

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Fig.2.

Fig.3.

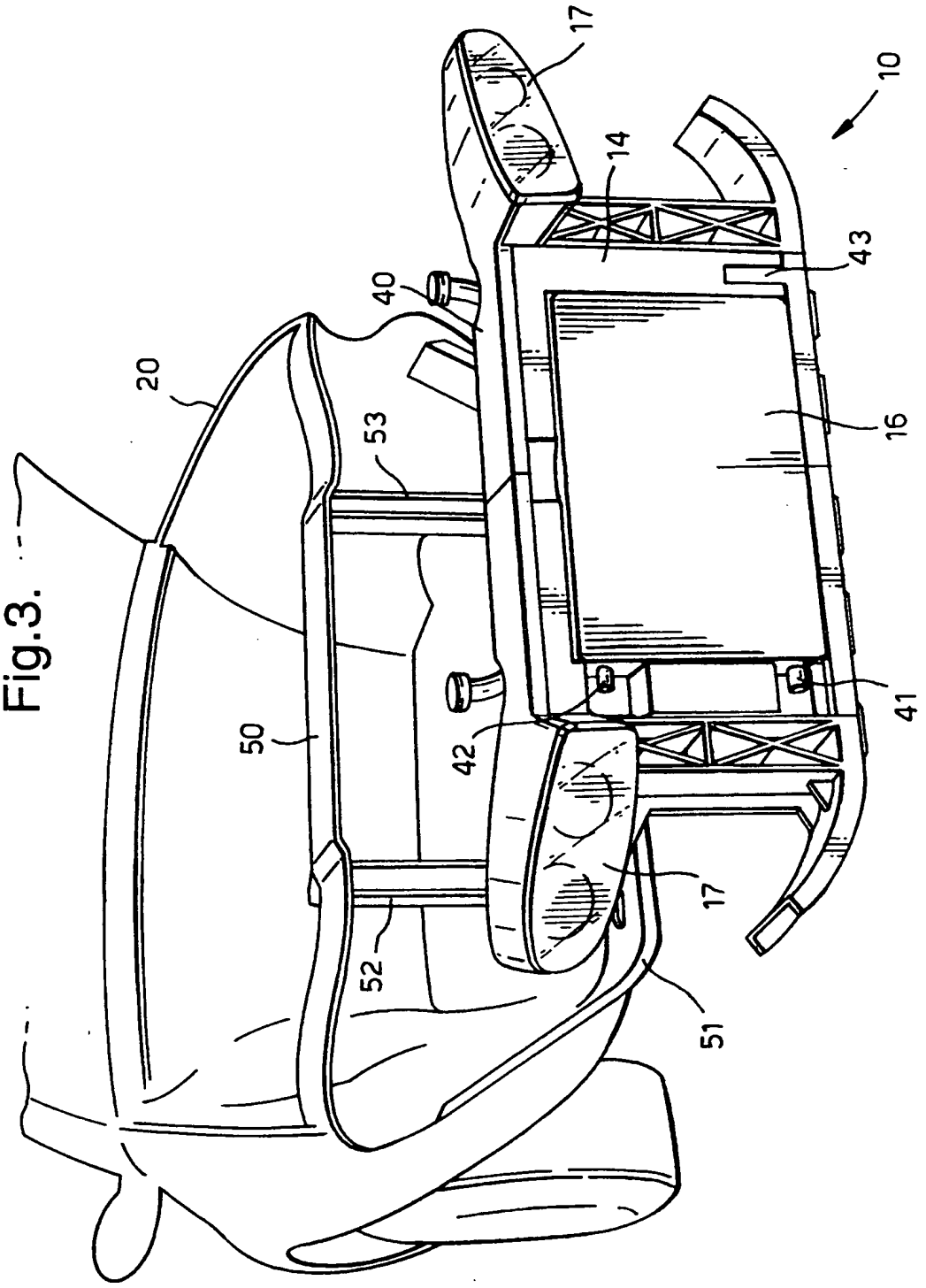
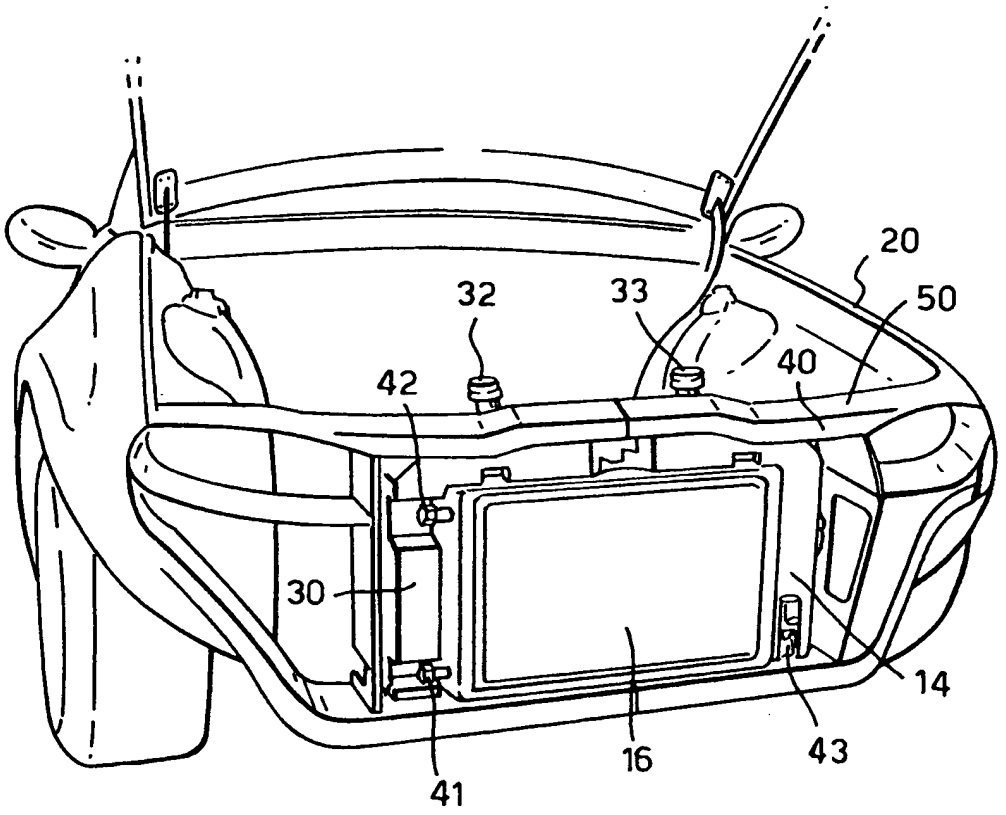


Fig.4.



INTERNATIONAL SEARCH REPORT

International Application No
PC./GB 99/01166

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B62D25/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	DATABASE WPI Section PQ, Week 9850 Derwent Publications Ltd., London, GB; Class Q17, AN 98-589203 XP002900565 -& JP 10 264858 A (AISIN SEIKI KK), 6 October 1998 (1998-10-06) abstract	1,4,11, 13
A	---	6,14
X	DE 195 20 870 A (ROBERT BOSCH GMBH) 12 December 1996 (1996-12-12) the whole document	1,6,8
A	---	4,7, 9-11,13, 14
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[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of mailing (day/month/year) 18 August 2000 (18.08.00)	
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Applicant WILSON, Philip, S.	

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(74) Agents: **BARUFKA, Jack, S.** et al.; Pillsbury Madison & Sutro LLP, 1100 New York Avenue, N.W., Washington, D.C. 20005 (US).

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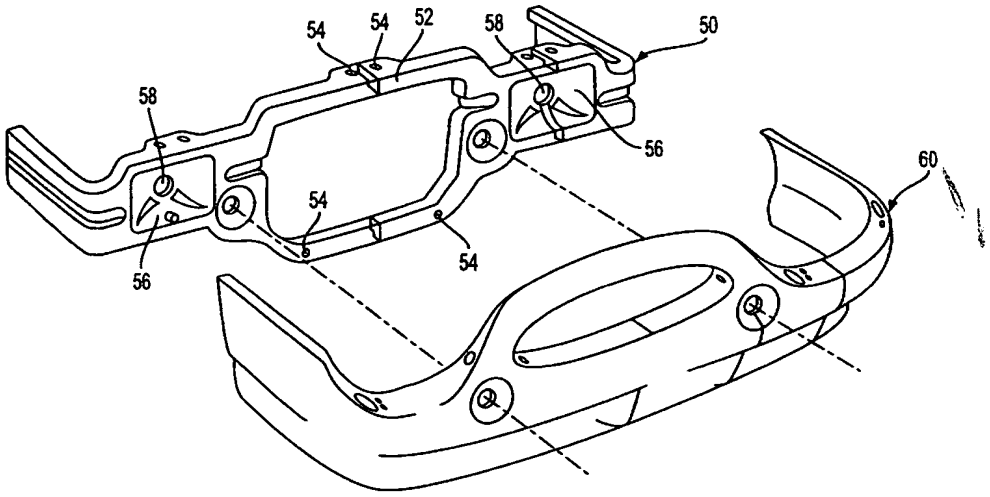
[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR BLOW MOLDING LARGE REINFORCED PLASTIC PARTS



(57) Abstract: A method for molding large parts, comprises the steps of providing a reinforced plastic melt (41) comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, at least 50% of the reinforcement particles having a thickness of less than about 20 nanomenters, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; communicating a tubular formation of the plastic melt to a mold assembly having a mold cavity (44) defined by mold surfaces (43), the mold surfaces (43) corresponding to a configuration of the part to be molded; applying pressurized gas to an interior of the tubular formation to expand the tubular formation into conformity with the mold surfaces (43); and solidifying the plastic melt to form the part; and removing the part from the mold assembly.

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(15) **Information about Correction:**
see PCT Gazette No. 34/2002 of 22 August 2002, Section II

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPARATUS FOR BLOW MOLDING LARGE REINFORCED PLASTIC PARTS

BACKGROUND OF THE INVENTION

The present invention relates to blow molding methods and apparatuses, and, more particularly, a blow molding method and apparatus for producing large, reinforced plastic parts.

Recently, there has been an increase in the demand and applications for large, molded plastic parts, specifically parts that are greater than about 2 lbs. in weight and having a total surface area of greater than about 400 sq. inches. As a result, some of these parts have become quite complex. One example of this can be seen in radiator supports for automobiles. Design engineers are now integrating many features into the radiator support to reduce tooling and manufacturing costs.

The usefulness of blow molding techniques for forming such parts has not been practical due to the structural characteristics of the plastic material conventionally used in blow molding techniques. That is, the ability to blow molding large complex parts is limited by the fact that the parts produced can be only so large or so thin before the parts lose their structural integrity and impact resistance.

Heretofore, in order to reinforce various large complex plastic parts, such parts would conventionally be reinforced by mineral fillers or glass fibers. However, such reinforcement cannot be used effectively in blow molding operations, because the glass fibers limit parison expansion characteristics and also have a deleterious effect on the blow molding assembly itself. Furthermore, such reinforcement has a deteriorating effect on impact resistance of the part.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the problems noted above. In achieving this object, the present invention provides a method for blow molding large, plastic parts. Accordingly, the present invention provides a method for molding large parts, comprising the steps of providing a reinforced plastic melt comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; communicating a tubular formation of the plastic melt to a mold assembly having a mold cavity defined by mold surfaces, the mold surfaces corresponding to a configuration of the part to be molded, an amount of the plastic melt communicated to the mold assembly being sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches; applying pressurized gas to an interior of said tubular formation to expand the tubular formation into conformity with the mold surfaces; solidifying the plastic melt to form the part; and

removing said part from said mold assembly.

It is also an object of the invention to blow mold particular parts for automotive applications, which has heretofore been impractical.

In one embodiment, a substantially hollow, integrally formed radiator and light support structure for a motor vehicle is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the integrally formed radiator and light support structure, at least 50% of the reinforcement particles have a

thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The structure comprises a radiator frame portion, having apertures for securing a motor vehicle radiator to the support structure. A pair of light receiving recesses of the support structure are constructed and arranged to mount headlights for the motor vehicle. The recesses have apertures for receiving electrical connecting portions of the lights.

In another embodiment, there is provided a hollow, sealed front end bumper that comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers. A fluid consuming component is constructed and arranged to be mounted on and used by the motor vehicle. A conduit communicates the fluid consuming component with the sealed interior of the hollow bumper, thus permitting said hollow sealed bumper to serve as a fluid reservoir for the fluid consuming component.

In another embodiment, there is provided a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle. The assembly is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the support structure assembly, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The integrally formed assembly includes i) a hollow

radiator frame portion, and apertures formed in the frame portion for securing a motor vehicle radiator to the frame portion, ii) a pair of light receiving recesses constructed and arranged to mount for the motor vehicle. Apertures are formed in the recesses for connecting the lights with an electrical power source, and iii) a hollow bumper portion constructed and arranged to be mounted to a front end of a motor vehicle.

Other objects and advantages of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the present invention is described herein with reference to the drawing wherein:

FIGS. 1-3 are cross sectional views of a blow molding assembly, and illustrating various steps used in a blow molding operation in accordance with one aspect of the present invention;

FIG. 4 is a perspective view of a blow-molded combination radiator support and light support structure in accordance with a further aspect of the present invention;

FIG. 5 is a perspective view of a motor vehicle, with certain components removed to better reveal others, and illustrating the combination of a hollow bumper, fluid consuming component, and conduit for communicating the bumper with the fluid consuming component in accordance with yet a further aspect of the present invention;

FIG. 6 is an enlarged perspective view of the front end of the motor vehicle illustrated in FIG. 5; and

FIG. 7 is a perspective view of an integral, blow-molded bumper and radiator support and headlight support assembly in accordance with yet another aspect of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrated in Figure 1 is a blow molding assembly, generally indicated at 10, in accordance with the present invention. The assembly 10 includes an extruder nozzle 12 connected with a tubular head assembly 14. The tubular head assembly 14 is provided with an internal tubular core 18. An ejecting mechanism 24 is disposed in the space between the tubular head assembly 14 and the core 18.

A hot plastic melt 20 is supplied through an extruder nozzle 12 into the tubular head assembly 14. A hot plastic preform 25 is produced in the cavity between the core 18 and the assembly 14. During this process the lower end of the head assembly 14 is firmly engaged by a movable base plate 26, constituting the upper portion of a hydraulic ram structure, for sealing the lower end of the cavity between core 18 and head assembly 14. The blow molding assembly further comprises a mold assembly 29, which has internal mold surfaces defining a die cavity. The die surfaces correspond to the external surface shape of the part to be blow molded. In the preferred embodiment, the mold assembly comprises parts capable of relative movement therebetween. More specifically, two mold parts 36 and 37 form side walls of the die cavity, and the base plate 26 forms the bottom wall when the base plate 26 is moved to its lowered position as illustrated in Figure 2.

In operation, the mold assembly 29 starts in the open configuration, as shown in Figure 1. The base plate 26 is pressed firmly against the head assembly 14 and closes the latter so that the preform 25 can be formed. The movable base plate 26 is then moved downwardly to drop a parison 41 of the hot plastic melt 20 (see Figure 2). The ejecting ram mechanism 24 can be thrust forward to assist parison formation. At about the same speed as the preform 25 is ejected, the base plate 26 is lowered, while supporting the bottom of the tubular parison 41, and the second mold assembly 29 is closed. At the same time,

compressed air or other gases or vapors under pressure are then blown through bore 38 in the core 18, so that the parison 41 is blown out and pressed firmly against the walls or surfaces 43 defining the cavity 44 of the mold assembly 29, the parison thus assuming the shape of the mold cavity. The amount of plastic melt 20 communicated in the form of tubular parison 41 to the mold assembly is sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches, as the present invention is primarily concerned with larger parts of this magnitude. Smaller parts are not benefited vis-à-vis reinforcement to the same extent as larger parts (smaller parts usually do not require the same degree of structural integrity as larger parts).

Preferably, the mold assembly 29 is provided with appropriate water cooling lines and a temperature control unit in conventional fashion for regulating the temperature of the mold assembly.

After the part 46 has solidified, the mold assembly 29 is opened, and the part 46 is removed.

In accordance with the present invention, the plastic melt 20 (and thus the resultant part) comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the plastic melt 20, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. In accordance with the method described above, a tubular formation in the form of parison 41 of the plastic melt is communicated to the mold assembly 29. The mold surfaces 43 correspond to a configuration of the part to be molded. Pressurized gas is applied through conduit or port 38 to an interior of the tubular formation 41 to expand the tubular formation into conformity with the mold surfaces 43. The

plastic melt when forced into conformity with surfaces 43 is then permitted to solidify (e.g, by cooling the mold assembly 29) to form the part 46. The solidified part is then removed from the mold assembly 29 and after the mold assembly 29 is opened.

The reinforcement filler particles, also referred to as "nanoparticles" due to the magnitude of their dimensions, each comprise one or more generally flat platelets. Each platelet has a thickness of between 0.7-1.2 nanometers. Generally, the average platelet thickness is approximately 1 nanometer thick. The aspect ratio (which is the largest dimension divided by the thickness) for each particle is about 50 to about 300.

The platelet particles or nanoparticles are derivable from larger layered mineral particles. Any layered mineral capable of being intercalated may be employed in the present invention. Layered silicate minerals are preferred. The layered silicate minerals that may be employed include natural and artificial minerals. Non-limiting examples of more preferred minerals include montmorillonite, vermiculite, hectorite, saponite, hydrotalcites, kanemite, sodium octosilicate, magadite, and kenyaite. Mixed Mg and Al hydroxides may also be used. Among the most preferred minerals is montmorillonite.

To exfoliate the larger mineral particles into their constituent layers, different methods may be employed. For example, swellable layered minerals, such as montmorillonite and saponite are known to intercalate water to expand the inter layer distance of the layered mineral, thereby facilitating exfoliation and dispersion of the layers uniformly in water. Dispersion of layers in water is aided by mixing with high shear. The mineral particles may also be exfoliated by a shearing process in which the mineral particles are impregnated with water, then frozen, and then dried. The freeze dried particles are then mixed into molten polymeric material and subjected to a high sheer mixing operation so as to peel individual

platelets from multi-platelet particles and thereby reduce the particle sizes to the desired range.

The plastic melt 20 utilized in accordance with the present invention are prepared by combining the platelet mineral with the desired polymer in the desired ratios. The components can be blended by general techniques known to those skilled in the art. For example, the components can be blended and then melted in mixers or extruders. Preferably, the plastic melt 20 is first manufactured into pellet form. Then pellets are then plasticized in the extruder 1 to form the plastic melt 20..

Additional specific preferred methods, for the purposes of the present invention, for forming a polymer composite having dispersed therein exfoliated layered particles are disclosed in U.S. Patent Nos. 5,717,000, 5,747,560, 5,698,624, and WO 93/11190, each of which is hereby incorporated by reference. For additional background, the following are also incorporated by reference: U.S. Patent Nos. 4,739,007 and 5,652,284

Preferably, the thermoplastic used for the purposes of the present invention is a polyolefin or a blend of polyolefins. The preferred polyolefin is at least one member selected from the group consisting of polypropylene, ethylene-propylene copolymers, thermoplastic olefins (TPOs), and thermoplastic polyolefin elastomers (TPEs).

The exfoliation of layered mineral particles into constituent layers need not be complete in order to achieve the objects of the present invention. The present invention contemplates that at least 50% of the particles should be less than about 20 nanometers in thickness and, thus, at least 50% of the particles should be less than about 20 platelets stacked upon one another in the thickness direction. In addition, at least 99% of the reinforcement particles should have a thickness of less than about 30 nanometers. With this extent of exfoliation, with a loading of less than 15% by volume, the benefits of the nanoparticles begin

to accrue with meaningful effect for many large thin part applications. For example, such loading of nanoparticles will provide a desired increase in the modulus of elasticity by about 50-70% over conventional fillers.

More preferably, at least 50 % of the particles should have a thickness of less than 10 nanometers. At this level, an additional increase of about 50-70% in the modulus of elasticity is achieved in comparison with the 50% of particles being less than 20 nanometer thick as discussed above. This provides a level of reinforcement and impact resistance that would be highly suitable for most motor vehicle bumper applications.

Preferably, at least 70% of the particles should have a thickness of less than 5 nanometers, which would achieve an additional 50-70% increase in the modulus of elasticity in comparison with the 50% of less than 10 nanometer thickness exfoliation discussed above. This provides ideal reinforcement and impact resistance for large thin parts that must withstand greater degrees of impart. It is always preferable for at least 99% of the particles to a thickness of less than about 30 nanometers (i.e., less than about 30 layers or platelets thick), as particles greater than this size act as stress concentrators..

It is most preferable to have as many particles as possible to be as small as possible, ideally including only a single platelet.

As noted above, the preferred aspect ratio (which is the largest dimension divided by the thickness) for each particle is about 50 to about 300. At least 80% of the particles should be within this range. If too many particles have an aspect ratio above 300, the material becomes too viscous for forming parts in an effective and efficient manner. If too many particles have an aspect ratio of smaller than 50, the particle reinforcements will not provide the desired reinforcement characteristics. More preferably, the aspect ratio for each particle is

between 100-200 . Most preferably, at least 90% of the particles have an aspect ratio within the 100-200 range.

Generally, in accordance with the present invention, the plastic melt 20 and hence the parts to be manufactured should contain less than 15% by volume of the reinforcement particles of the type contemplated herein. The balance of the part is to comprise an appropriate polyolefin material and suitable additives. If greater than 15% by volume of reinforcement filler is used, the viscosity of the composition becomes too high and thus difficult to mold.

Turning now to FIG. 4, there is shown a substantially hollow, integrally formed radiator and light support structure for a motor vehicle, generally indicated at 50, and manufactured in a blow molding operation in accordance with the present invention. The structure 50 is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the integrally formed radiator and light support structure 50, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The structure 50 comprises a radiator frame portion 52, having apertures 54 for securing a motor vehicle radiator (not shown for sake of clarity) to the support structure 50. A pair of light receiving recesses 56 of the support structure 50 are constructed and arranged to mount headlights (not shown for sake of clarity) for the motor vehicle. The recesses 56 having apertures 58 for receiving electrical connecting portions of the lights.

As shown, the support structure can be nestingly received with respect to a motor vehicle fascia, indicated at 60.

Turning now to FIGS. 5 and 6, there is shown a hollow, sealed front end bumper, generally indicated at 70. The bumper 70 is shown mounted to the front end of a motor vehicle, generally indicated at 72. The hollow bumper comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. A fluid consuming component, such as a conventional windshield wiper fluid spraying assembly, generally indicated at 74 in FIG. 5, is constructed and arranged to be mounted on and used by the motor vehicle. A conduit 76 communicates the fluid consuming component with the sealed interior of the hollow bumper 70, thus permitting said hollow sealed bumper to serve as a fluid reservoir for the fluid consuming component (e.g., the wiper fluid spraying assembly 74).

The fluid consuming component to which the bumper 70 is communicated may be other components in the motor vehicle as well, such as the radiator 78, which may be communicated with the interior of the bumper 70 by conduit 80 (see FIG. 5).

It should also be appreciated that the bumper 70 may be divided so as to have two separate compartments. For example, in FIG. 6 it can be appreciated that the interior of bumper 70 is divided into compartments 84 and 86, with the compartment 84 communicating with the wiper spray assembly 74 via conduit 76, and the compartment 86 communicating with radiator 78 via conduit 80. Separate compartment filler necks 88 and 90 are provided for filling compartments 84 and 86, respectively, with the

appropriate fluids. Doors 92 and 94 are pivotally mounted close off access to necks 88 and 90, respectively, and to permit access to the necks when filling is desired.

Turning now to FIG. 7, there is shown a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, generally indicated at 100. The assembly 100 is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the support structure assembly, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers. The integrally formed assembly includes i) a hollow radiator frame portion 102, and apertures 104 formed in the frame portion for securing a motor vehicle radiator (not shown for sake of clarity) to the frame portion 102, ii) a pair of light receiving recesses 106 constructed and arranged to mount lights (not shown for sake of clarity of illustration) for the motor vehicle. Apertures 108 are formed in the recesses 106 for connecting the lights with an electrical power source, and iii) a hollow bumper portion 110 constructed and arranged to be mounted to a front end of a motor vehicle.

By utilizing plastic melt with the loading of nanoparticles discussed above (e.g., less than 15% of a total volume of the plastic melt), higher modulus of elasticity of conventional large plastic parts can be achieved, and thus be manufactured with a reduced wall thickness while maintaining the same required impact resistance. In one example, the modulus of the material used to form a bumper is increased to between about 200,000 to about 500,000 PSI.

In accordance with the present invention, by adding the exfoliated platelet material in accordance with the above, the modulus of the large, thin part can be increased without significantly losing impact resistance. Because the modulus is increased, large thin parts,

such as bumpers, can be made thinner than what was otherwise possible. More specifically, bumpers for automobiles must have sufficient impact resistance or toughness to withstand various standard automotive impact tests.

For example, an automotive bumper must withstand a typical dart (puncture type) impact test wherein the bumper will not crack or permanently deform upon impact of at least 200 inch pounds force at a temperature of -30°C or lower. In a conventional IZOD impact test, it is desirable for the bumper to withstand at least 10 ft pounds/inch at room temperature and at least 5 ft pounds/inch at -30°C. In order to withstand cracking at such force levels, the modulus for the conventional bumper is typically between about 70,000 to about 150,000 pounds per square inch. (PSI). In accordance with the present invention, the modulus can be increased by a factor of 2 to 3 times, without significantly effecting the impact resistance.

In addition to the above mentioned benefits, use of the nanoparticle reinforced plastic melt enables the coefficient of linear thermal expansion to be reduced to less than 40 x10-6 inches of expansion per inch of material per degree Fahrenheit (IN/IN)/°F, which is less than 60% of what was previously achievable for thermoplastic motor vehicle bumpers that meet the required impact tests. As a further benefit, the surface toughness of the bumper can be improved. The improved surface toughness provided by the nanoparticles greatly reduces handling damage and part scrap. It also eliminates the need for the extra packaging and protective materials and the labor involved.

In addition, it is possible to double the modulus of polymers without significantly reducing toughness. Thus, it is possible to produce parts like bumpers using 20-35% thinner wall sections that will have comparable performance. The use of nanoparticles can provide the mechanical, thermal, and dimensional property enhancements, which are typically obtained by adding 20-50% by weight of glass fibers or mineral fillers or combinations

thereof to polymers. However, only a few percent of nanoparticles are required to obtain these property enhancements.

As a result of the fact that such low levels of nanoparticles are required to obtain the requisite mechanical properties, many of the typical negative effects of the high loadings of conventional reinforcements and fillers are avoided or significantly reduced. These advantages include: lower specific gravity for a given level of performance, better surface appearance, toughness close to that of the unreinforced base polymer, and reduced anisotropy in the molded parts.

It is preferable for these parts to have reinforcement particles of the type described herein comprising about 2-10% of the total volume of the panel, with the balance comprising the polyolefin substrate. It is even more preferable for these exterior panels to have reinforcement particles of the type contemplated herein comprising about 3%-5% of the total volume of the panel.

In accordance with another specific embodiment of the present invention, it is contemplated that the blow molding apparatus can be used to make large, highly reinforced parts having a modulus of elasticity of 1,000,000 or greater. Conventionally, these parts typically require loadings of 25-40% by volume of glass fiber reinforcement. This amount of glass fiber loading would result in a high viscosity of any melt pool that could be used in the blow molding apparatus of the present invention and would thus render the blow molding apparatus disclosed herein largely impractical for such application.

Use of the plastic melt 20 as described above enables the blow molding apparatus disclosed herein to manufacture large parts that can be provided with impact resistance characteristics that were not previously attainable. For example, the blow molding system of the present invention is able to manufacture large parts having a modulus of elasticity of

greater than 1,000,000 PSI by use of the plastic melt reinforced with loadings of 8-15% by volume of nanoparticles, with at least 70% of the nanoparticles having a thickness of 10 nanometers or less. As with the above described embodiment, the plastic melt used has substantially the same material composition as the part to be manufactured.

In this case of molding large parts with a modulus of elasticity greater than 1,000,000 PSI, it may be desirable to use engineering resins instead of polyolefins. Such engineering resins may include polycarbonate (PC), acrylonitrile butadiene styrene (ABS), a PC/ABS blend, polyethylene terephthalates (PET), polybutylene terephthalates (PBT), polyphenylene oxide (PPO), or the like. Generally, these materials in an unreinforced state have a modulus of elasticity of about 300,000 PSI – 350,000 PSI. At these higher loadings of nanoparticles (8-15% by volume), impact resistance will be decreased, but to a much lower extent than the addition of the conventional 25-40% by volume of glass fibers.

Although certain embodiments of the invention have been described and illustrated herein, it will be readily apparent to those of ordinary skill in the art that a number of modifications and substitutions can be made to the blow molding system disclosed and described herein without departing from the true spirit and scope of the invention.

What is claimed is:

1. A method for molding large parts, comprising the steps of:

providing a reinforced plastic melt comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers;

communicating a tubular formation of said plastic melt to a mold assembly having a mold cavity defined by mold surfaces, said mold surfaces corresponding to a configuration of the part to be molded, an amount of said plastic melt communicated to said mold assembly being sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches;

applying pressurized gas to an interior of said tubular formation to expand said tubular formation into conformity with said mold surfaces;

solidifying said plastic melt to form said part; and

removing said part from said mold assembly.

2. A method according to claim 1, wherein said part comprises a substantially hollow, integrally formed radiator and light support structure for a motor vehicle, said method including

forming a radiator frame portion of said support structure, and forming apertures in said frame portion for securing a motor vehicle radiator to said support structure,

forming a pair of light receiving recesses of said support structure constructed and arranged to mount lights for said motor vehicle, and forming apertures in said recesses for securing said lights to said support structure.

3. A method according to claim 2, wherein said lights comprise headlights.

4. A method according to claim 3, wherein said support structure further include another pair of recesses constructed and arranged to mount parking lights therein.

5. A method according to claim 2, wherein said forming of said apertures in said frame portion is accomplished after said part is removed from said mold assembly.

6. A method according to claim 2, wherein said forming of said apertures in said recesses is accomplished after said part is removed from said mold assembly.

7. A method according to claim 2, further comprising:

providing a front fascia for a motor vehicle;

nestingly disposing said support structure with respect to said front fascia.

8. A method according to claim 1, wherein said part comprises a substantially hollow,

bumper for a motor vehicle, said method further comprising:

mounting said bumper to an exterior of the motor vehicle at an end of the motor vehicle;

communicating and interior of said bumper to a fluid consuming component of the motor vehicle; and

filling said bumper with fluid to enable said bumper to serve as a fluid reservoir for said fluid consuming component.

9. A method according to claim 8, further comprising provided said bumper with a port for receiving said fluid.

10. A method according to claim 8, wherein said component comprises a windshield wiper fluid spraying assembly.

11. A method according to claim 10, wherein said component comprises a radiator.

12. A method according to claim 10, wherein said bumper comprises two compartments, wherein a first of said compartments is communicated with said windshield wiper spraying assembly, and wherein a second of said compartments is communicated with a radiator.

13. A method according to claim 1, wherein said part comprises a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, said method including

forming a radiator frame portion of said integrally formed assembly, and forming apertures in said frame portion for securing a motor vehicle radiator to said support structure,

forming a pair of light receiving recesses of said integrally formed assembly constructed and arranged to mount lights for said motor vehicle, and forming apertures in said recesses for securing said lights to said support structure; and

forming a bumper portion of said integrally formed assembly; and

mounting said assembly on the front end of the motor vehicle.

14. In combination in a motor vehicle:

a hollow, sealed bumper constructed and arranged to be mounted on the motor vehicle, said hollow bumper comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers;

a fluid consuming component constructed and arranged to be mounted on and used by the motor vehicle;

a conduit communicating said fluid consuming component with said hollow bumper, thus permitting said hollow sealed bumper to serve as a fluid reservoir for said fluid consuming component.

15. A substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, and formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the support structure assembly, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; said integrally formed assembly including i) a hollow radiator frame portion, and apertures formed in said frame portion for securing a motor vehicle radiator to said frame portion, ii) a pair of light receiving recesses constructed and arranged to mount lights for said motor vehicle, and apertures formed in said recesses for connecting said lights with an electrical power source, and iii) a hollow bumper portion constructed and arranged to be mounted to a front end of a motor vehicle.

16. A substantially hollow, integrally formed radiator and light support structure for a motor vehicle, comprising a radiator frame portion of said support structure having apertures for securing a motor vehicle radiator to said support structure, and a pair of light receiving recesses of said support structure constructed and arranged to mount lights for said motor vehicle, said recesses having apertures for receiving electrical connecting portions of the lights, said integrally formed radiator and light support structure

comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the support structure, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers.

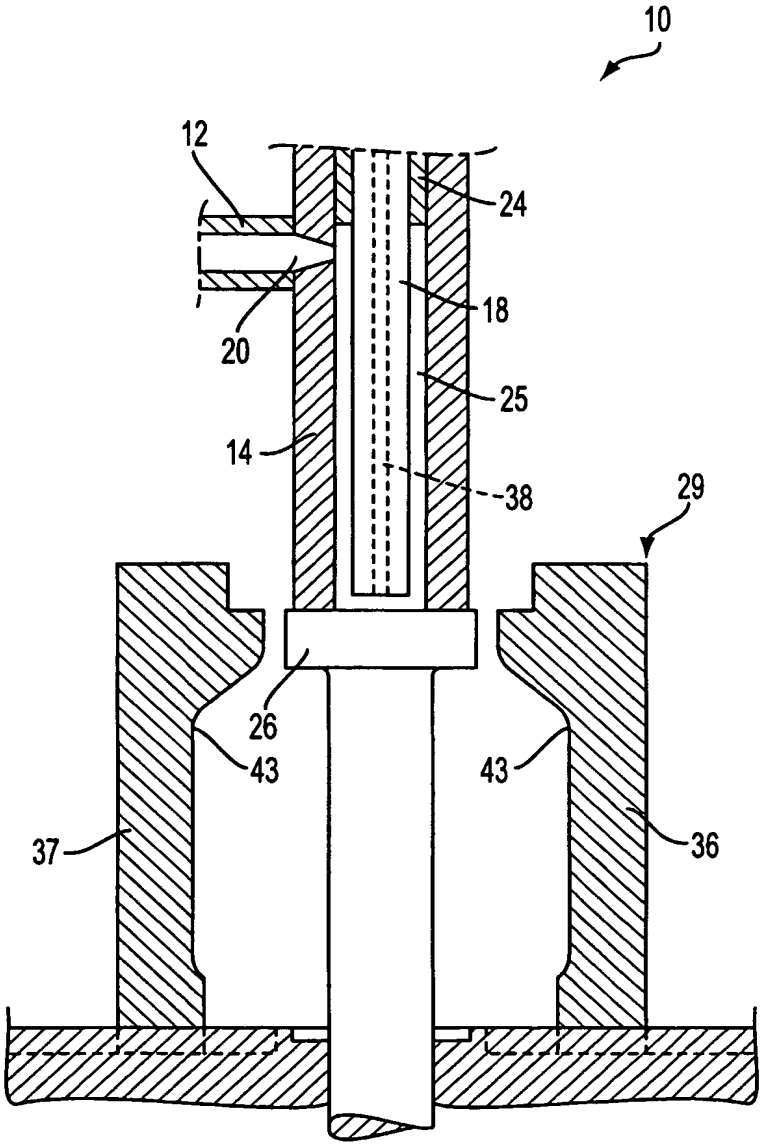

FIG. 1

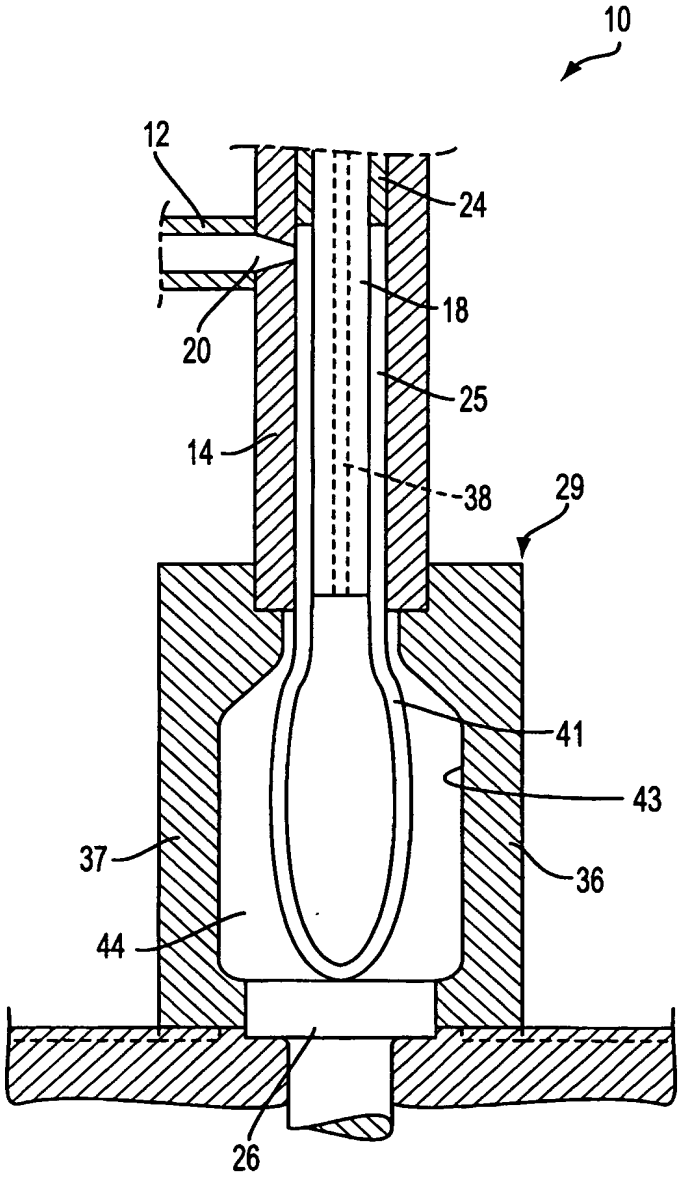

FIG. 2

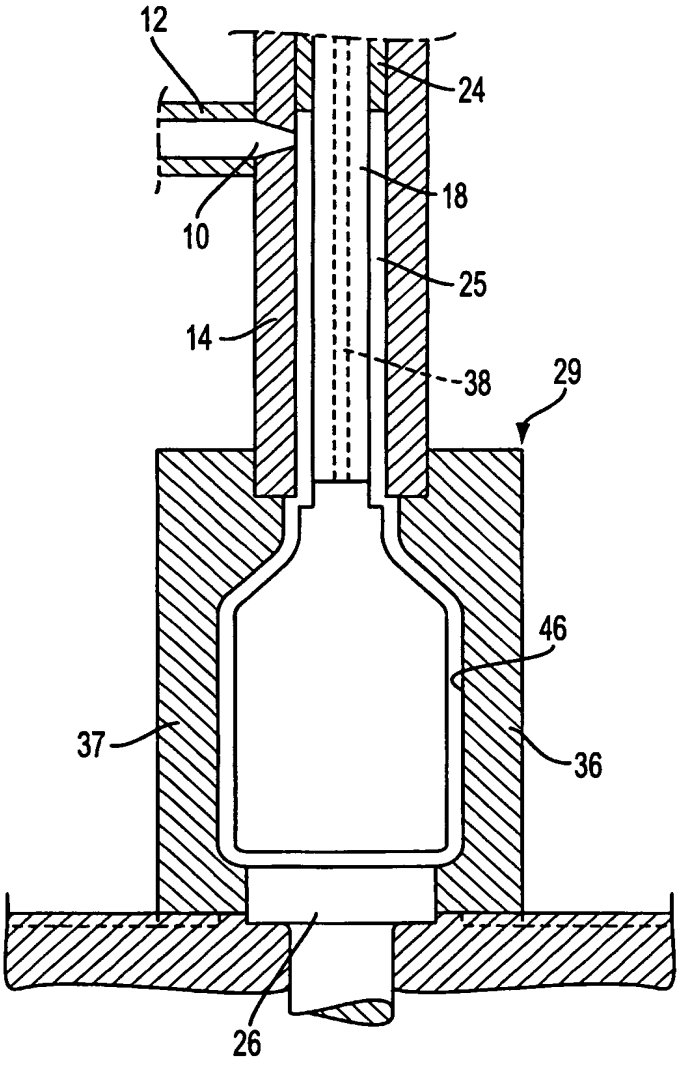

FIG. 3

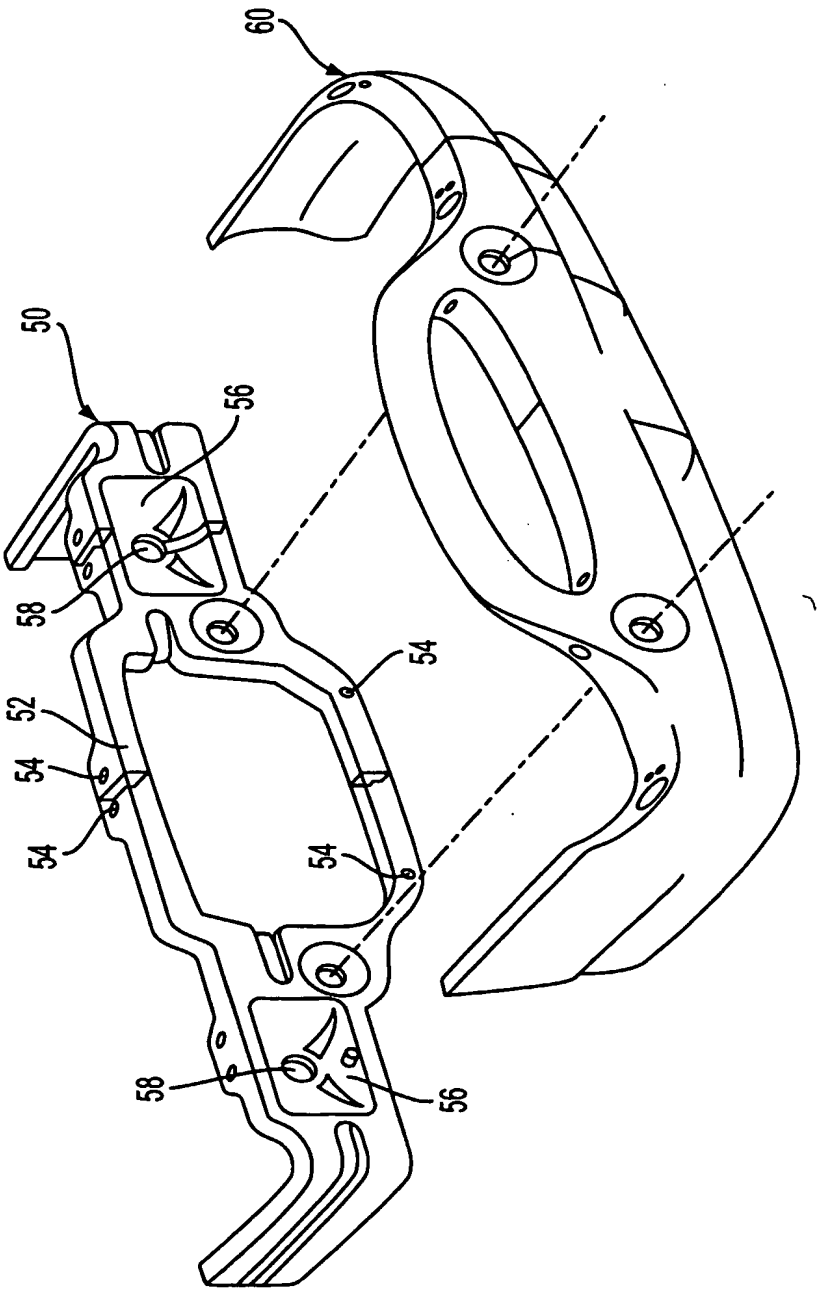

FIG. 4

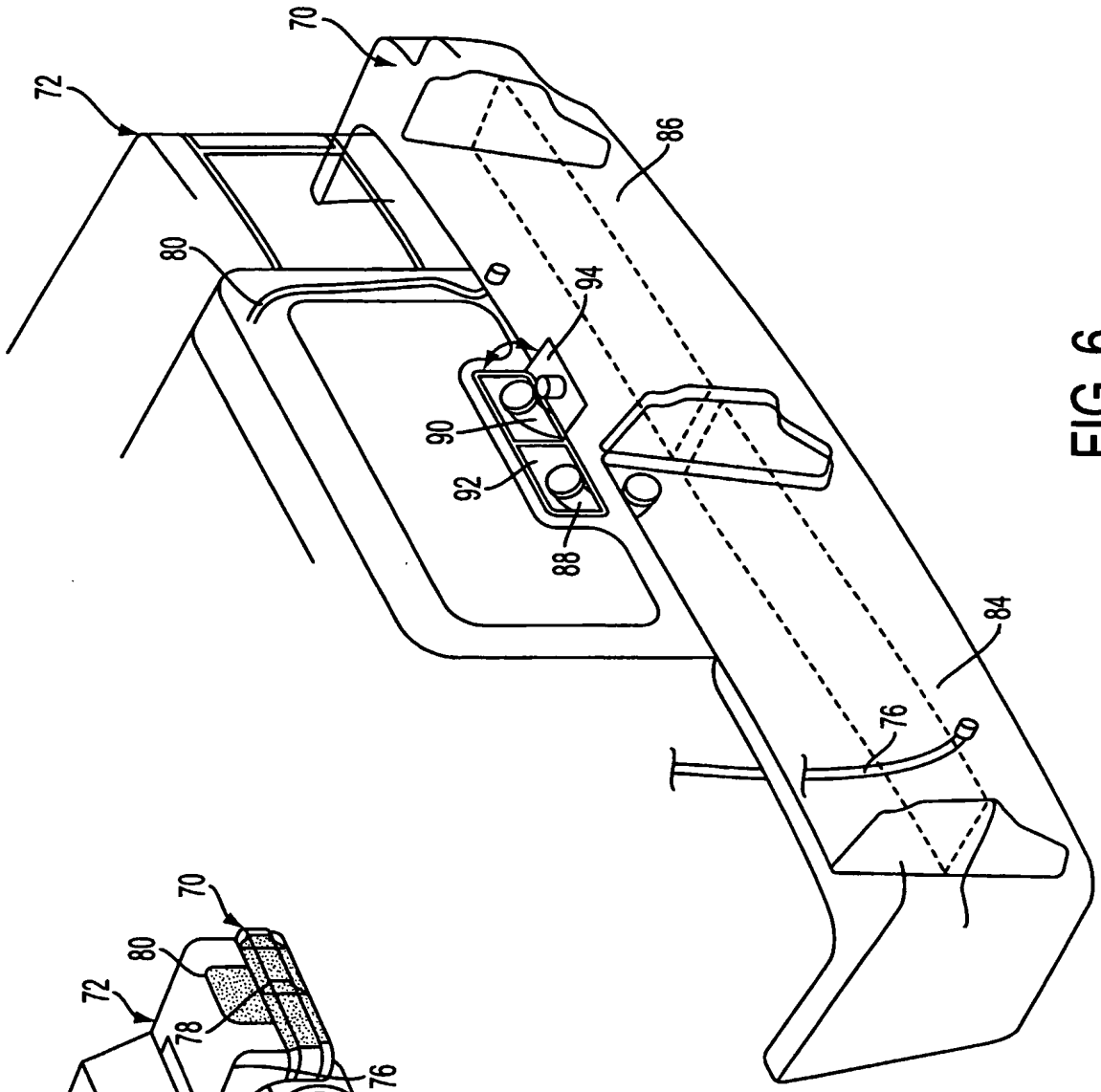

FIG. 6

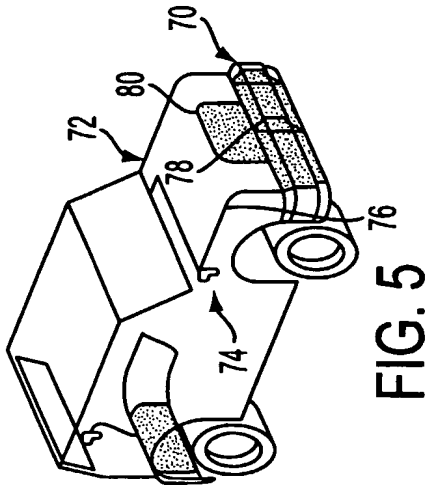

FIG. 5

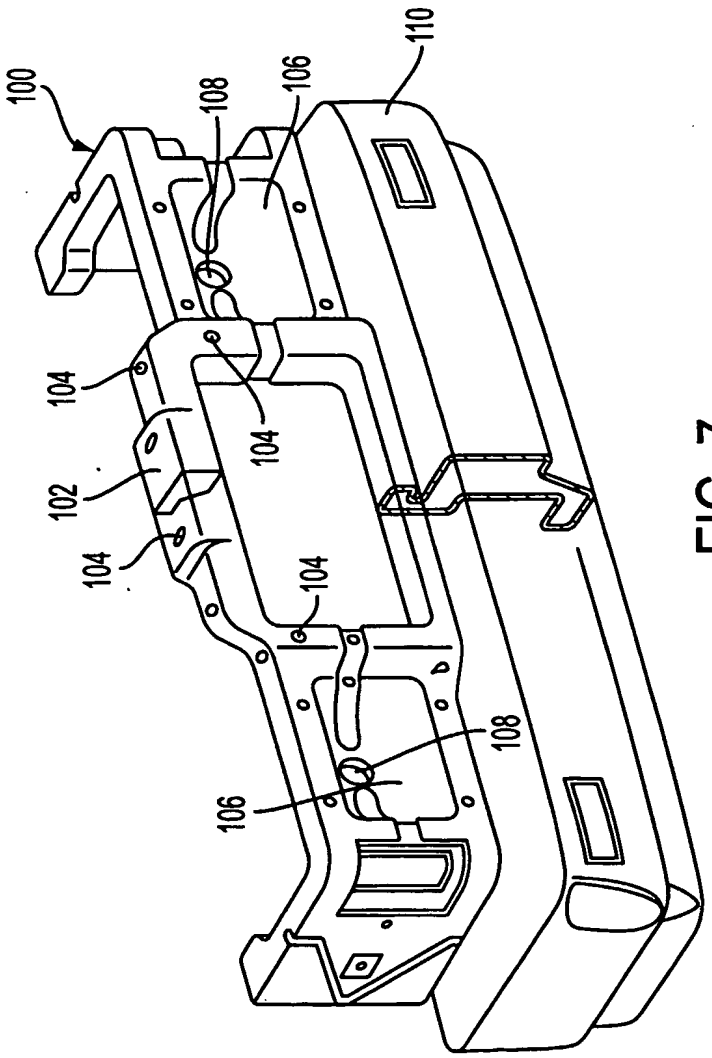

FIG. 7

ID-

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
MAGNA376PCT1		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 99/ 29991	17/12/1999	21/12/1998
Applicant		
MAGNA INTERNATIONAL OF AMERICA, INC. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

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   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 4

   [ ] as suggested by the applicant.

   [X] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A method for molding large parts, comprises the steps of providing a reinforced plastic melt (41) comrpising at least one thermoplastic material and reinforcement particles dispersed within at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than 30 nanometers; communicating a tubular formation of the plastic melt to a mold assembly (29) having a mold cavity (44) defined by molds surfaces (43), the mold surfaces (43) corresponding to a configuration of the part to be molded; applying pressurized gas to an interiorof the tubular formation to expand the tubular formation into conformity with the mold surfaces (43); and solidifying the plastic melt to form the part; and removing the part from the mold assembly.

INTERNATIONAL SEARCH REPORT

Interna[redacted]l Application No
PCT/US 99/29991

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C49/04 B60R19/48 B60R19/03 B60K11/04 B62D21/16
B62D25/08 B60S1/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C B60R B60K B62D B65D B60S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 810 260 A (BAYER AG) 3 December 1997 (1997-12-03)	1
A	page 2, line 6 - line 10; claims 1-3,9 page 3, line 7, paragraph 11 page 3, line 47 - line 50 page 4, line 11 - line 16	2,8,13
X	EP 0 810 259 A (INST NEUE MAT GEMEIN GMBH ;BAYER AG (DE)) 3 December 1997 (1997-12-03) page 4, line 4 - line 17; claims	1
A	EP 0 747 451 A (AMCOL INTERNATIONAL CORP) 11 December 1996 (1996-12-11) page 18, line 37 -page 19, line 2	1,14-16

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2000	18/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Kosicki, T

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 876 033 A (DZIURLA HEINZ-JUERGEN ET AL) 24 October 1989 (1989-10-24) column 3, line 44 - line 52 column 4, line 26 - line 34	1,2,8,14
A	EP 0 738 580 A (NIPPON STEEL CORP ;NIPPON STEEL CHEMICAL CO (JP)) 23 October 1996 (1996-10-23)	1,14
P,X	WO 99 61281 A (MAGNA INTERNATIONAL OF AMERICA ;WILSON PHILLIP S (US)) 2 December 1999 (1999-12-02) claim 1	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/29991

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0810260	A	03-12-1997	DE	19621309 A	04-12-1997
			CA	2205974 A	28-11-1997
			JP	10081767 A	31-03-1998
EP 0810259	A	03-12-1997	DE	19621308 A	04-12-1997
EP 0747451	A	11-12-1996	US	5698624 A	16-12-1997
			US	5552469 A	03-09-1996
			US	5721306 A	24-02-1998
			US	5760121 A	02-06-1998
			CA	2178441 A	08-12-1996
			JP	9118518 A	06-05-1997
			US	5998528 A	07-12-1999
			US	5837763 A	17-11-1998
			US	5844032 A	01-12-1998
			US	5849830 A	15-12-1998
			US	5877248 A	02-03-1999
US 4876033	A	24-10-1989	DE	3619094 A	17-12-1987
			DE	3775624 A	13-02-1992
			EP	0249101 A	16-12-1987
			JP	1940924 C	23-06-1995
			JP	6068069 B	31-08-1994
			JP	62297353 A	24-12-1987
EP 0738580	A	23-10-1996	JP	7205264 A	08-08-1995
			US	5780129 A	14-07-1998
			WO	9518712 A	13-07-1995
WO 9961281	A	02-12-1999	AU	4007499 A	13-12-1999

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
MAGNA 376PCT 1		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/29991	17/12/1999	21/12/1998
International Patent Classification (IPC) or national classification and IPC B29C49/04		
Applicant MAGNA INTERNATIONAL OF AMERICA, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/07/2000	30.01.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Dorfschmidt, E Telephone No. +49 89 2399 2915

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/29991

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-15 as originally filed

Claims, No.:

1-16 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-16
	No:	Claims	
Inventive step (IS)	Yes:	Claims	2-16
	No:	Claims	1
Industrial applicability (IA)	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The documents, listed in the Search Report, do not disclose large molded parts according to the subject-matter of independent claims 14 to 16. Nowhere could be found a hint to the specific constructional details of such articles.

2. Therefore, the subject-matter of claims 14 to 16 seems to fulfil the requirements of Article 33 PCT with respect to novelty and inventive step.

3. Considering the subject-matter of claim 1 and the disclosure of US-A-3466701 (D1, known by the examiner's own knowledge) it is to be noted that D1 already describes the claimed **process** steps like providing a thermoplastic, communicating a tubular preform, applying pressurized gas, solidifying the melt and removing the article from the mold, see, e.g. Figures 1 to 8 with the description relating thereto. The specific used resin with respect to the nanoparticles is in this context of no importance, because there are not claimed specific process steps related to these particles.

   The use of nanoparticles in such extruded articles are generally known, see, e.g. EP-A-0810260 (D2) the description page 2, line 35 to page 3, line 50. Therefore, the subject-matter of claim 1 seems not to fulfil the requirements of Article 33 PCT with respect to inventive step.

4. If, however, present claims 14 to 16, directed to the article itself, are renumbered as claims 1 to 3 (when entering into the national phase), and if present 'method' claim 1 is renumbered as claim 4 and referred to the 'article' claims, then there could not be made any objections against this 'method' claim.

5. The dependent claims are concerned with further details of the invention and seem likewise to be novel and inventive.

Re Item VII

Certain defects in the international application

1. In contradiction with the requirements of Rule 6.3(b)(i) and (ii) PCT, the independent claims have not been cast in the two part form, with those features which in combination are part of the prior art being placed in the preamble.

2. The technical features mentioned in the claims are not followed by reference characters relating to these features, contrary to Rule 6.2(b) of the PCT. This applies to both the preamble and characterising portion.

3. A document reflecting the prior art described on page 1, is not identified in the description (Rule 5.1(a)(ii) PCT).

4. Documents D1 and D2 have not been identified in the description nor has the relevant background art disclosed therein been discussed. The requirements of Rule 5.1 (a)(ii) PCT are, thus, not fulfilled.

5. Figures 4 to 7 do not fulfill the requirements of Rule 11,13 PCT with respect to the text terms in the drawings.

Re Item VIII

Certain observations on the international application

The units of weight/area/pressure employed in, e.g. claim 1 and on pages 1, 6, 12, 13, etc. are not additionally expressed in terms of the units stipulated by Rule 10.1/(a)/and/(b) PCT.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
B29C 49/04, B60R 19/48, 19/03, B60K 11/04, B62D 21/16, 25/08, B60S 1/50

A1

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(43) International Publication Date: 29 June 2000 (29.06.00)

(21) International Application Number: PCT/US99/29991

(22) International Filing Date: 17 December 1999 (17.12.99)

(30) Priority Data:
60/113,064 21 December 1998 (21.12.98) US

(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application
US 60/113,064 (CON)
Filed on 21 December 1998 (21.12.98)

(71) Applicant *(for all designated States except US)*: MAGNA INTERNATIONAL OF AMERICA, INC. [US/US]; 600 Wilshire Drive, Troy, MI 48084 (US).

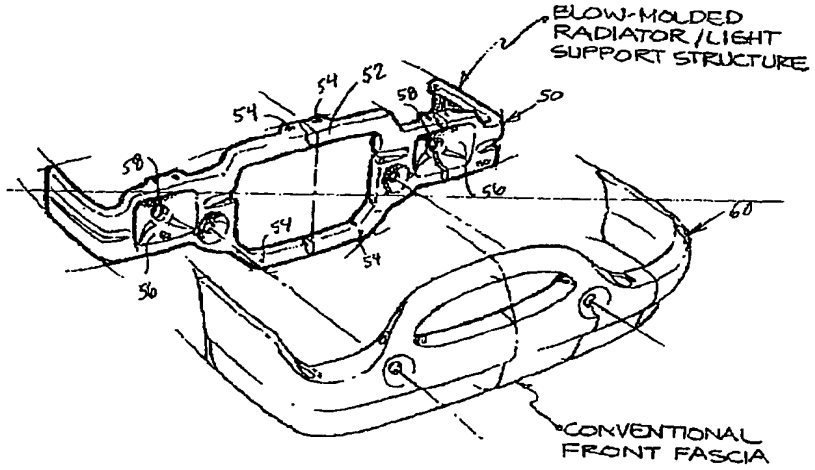
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: WILSON, Philip, S. [US/US]; 5480 Huron Hills Drive, Commerce Township, MI 48382 (US).

(74) Agents: BARUFKA, Jack, S. et al.; Pillsbury Madison & Sutro LLP, 1100 New York Avenue, N.W., Washington, D.C. 20005 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR BLOW MOLDING LARGE REINFORCED PLASTIC PARTS



(57) Abstract

A method for molding large parts, comprises the steps of providing a reinforced plastic melt (41) comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, at least 50% of the reinforcement particles having a thickness of less than about 20 nanomenters, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; communicating a tubular formation of the plastic melt to a mold assembly having a mold cavity (44) defined by mold surfaces (43), the mold surfaces (43) corresponding to a configuration of the part to be molded; applying pressurized gas to an interior of the tubular formation to expand the tubular formation into conformity with the mold surfaces (43); and solidifying the plastic melt to form the part; and removing the part from the mold assembly.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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METHOD AND APPARATUS FOR BLOW MOLDING LARGE REINFORCED PLASTIC PARTS

BACKGROUND OF THE INVENTION

The present invention relates to blow molding methods and apparatuses, and, more particularly, a blow molding method and apparatus for producing large, reinforced plastic parts.

Recently, there has been an increase in the demand and applications for large, molded plastic parts, specifically parts that are greater than about 2 lbs. in weight and having a total surface area of greater than about 400 sq. inches. As a result, some of these parts have become quite complex. One example of this can be seen in radiator supports for automobiles. Design engineers are now integrating many features into the radiator support to reduce tooling and manufacturing costs.

The usefulness of blow molding techniques for forming such parts has not been practical due to the structural characteristics of the plastic material conventionally used in blow molding techniques. That is, the ability to blow molding large complex parts is limited by the fact that the parts produced can be only so large or so thin before the parts lose their structural integrity and impact resistance.

Heretofore, in order to reinforce various large complex plastic parts, such parts would conventionally be reinforced by mineral fillers or glass fibers. However, such reinforcement cannot be used effectively in blow molding operations, because the glass fibers limit parison expansion characteristics and also have a deleterious effect on the blow molding assembly itself. Furthermore, such reinforcement has a deteriorating effect on impact resistance of the part.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the problems noted above. In achieving this object, the present invention provides a method for blow molding large, plastic parts. Accordingly, the present invention provides a method for molding large parts, comprising the steps of providing a reinforced plastic melt comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; communicating a tubular formation of the plastic melt to a mold assembly having a mold cavity defined by mold surfaces, the mold surfaces corresponding to a configuration of the part to be molded, an amount of the plastic melt communicated to the mold assembly being sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches; applying pressurized gas to an interior of said tubular formation to expand the tubular formation into conformity with the mold surfaces; solidifying the plastic melt to form the part; and

removing said part from said mold assembly.

It is also an object of the invention to blow mold particular parts for automotive applications, which has heretofore been impractical.

In one embodiment, a substantially hollow, integrally formed radiator and light support structure for a motor vehicle is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the integrally formed radiator and light support structure, at least 50% of the reinforcement particles have a

thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The structure comprises a radiator frame portion, having apertures for securing a motor vehicle radiator to the support structure. A pair of light receiving recesses of the support structure are constructed and arranged to mount headlights for the motor vehicle. The recesses have apertures for receiving electrical connecting portions of the lights.

In another embodiment, there is provided a hollow, sealed front end bumper that comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers. A fluid consuming component is constructed and arranged to be mounted on and used by the motor vehicle. A conduit communicates the fluid consuming component with the sealed interior of the hollow bumper, thus permitting said hollow sealed bumper to serve as a fluid reservoir for the fluid consuming component.

In another embodiment, there is provided a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle. The assembly is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the support structure assembly, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The integrally formed assembly includes i) a hollow

radiator frame portion, and apertures formed in the frame portion for securing a motor vehicle radiator to the frame portion, ii) a pair of light receiving recesses constructed and arranged to mount for the motor vehicle. Apertures are formed in the recesses for connecting the lights with an electrical power source, and iii) a hollow bumper portion constructed and arranged to be mounted to a front end of a motor vehicle.

Other objects and advantages of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the present invention is described herein with reference to the drawing wherein:

FIGS. 1-3 are cross sectional views of a blow molding assembly, and illustrating various steps used in a blow molding operation in accordance with one aspect of the present invention;

FIG. 4 is a perspective view of a blow-molded combination radiator support and light support structure in accordance with a further aspect of the present invention;

FIG. 5 is a perspective view of a motor vehicle, with certain components removed to better reveal others, and illustrating the combination of a hollow bumper, fluid consuming component, and conduit for communicating the bumper with the fluid consuming component in accordance with yet a further aspect of the present invention;

FIG. 6 is an enlarged perspective view of the front end of the motor vehicle illustrated in FIG. 5; and

FIG. 7 is a perspective view of an integral, blow-molded bumper and radiator support and headlight support assembly in accordance with yet another aspect of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrated in Figure 1 is a blow molding assembly, generally indicated at 10, in accordance with the present invention. The assembly 10 includes an extruder nozzle 12 connected with a tubular head assembly 14. The tubular head assembly 14 is provided with an internal tubular core 18. An ejecting mechanism 24 is disposed in the space between the tubular head assembly 14 and the core 18.

A hot plastic melt 20 is supplied through an extruder nozzle 12 into the tubular head assembly 14. A hot plastic preform 25 is produced in the cavity between the core 18 and the assembly 14. During this process the lower end of the head assembly 14 is firmly engaged by a movable base plate 26, constituting the upper portion of a hydraulic ram structure, for sealing the lower end of the cavity between core 18 and head assembly 14. The blow molding assembly further comprises a mold assembly 29, which has internal mold surfaces defining a die cavity. The die surfaces correspond to the external surface shape of the part to be blow molded. In the preferred embodiment, the mold assembly comprises parts capable of relative movement therebetween. More specifically, two mold parts 36 and 37 form side walls of the die cavity, and the base plate 26 forms the bottom wall when the base plate 26 is moved to its lowered position as illustrated in Figure 2.

In operation, the mold assembly 29 starts in the open configuration, as shown in Figure 1. The base plate 26 is pressed firmly against the head assembly 14 and closes the latter so that the preform 25 can be formed. The movable base plate 26 is then moved downwardly to drop a parison 41 of the hot plastic melt 20 (see Figure 2). The ejecting ram mechanism 24 can be thrust forward to assist parison formation. At about the same speed as the preform 25 is ejected, the base plate 26 is lowered, while supporting the bottom of the tubular parison 41, and the second mold assembly 29 is closed. At the same time,

compressed air or other gases or vapors under pressure are then blown through bore 38 in the core 18, so that the parison 41 is blown out and pressed firmly against the walls or surfaces 43 defining the cavity 44 of the mold assembly 29, the parison thus assuming the shape of the mold cavity. The amount of plastic melt 20 communicated in the form of tubular parison 41 to the mold assembly is sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches, as the present invention is primarily concerned with larger parts of this magnitude. Smaller parts are not benefited vis-à-vis reinforcement to the same extent as larger parts (smaller parts usually do not require the same degree of structural integrity as larger parts).

Preferably, the mold assembly 29 is provided with appropriate water cooling lines and a temperature control unit in conventional fashion for regulating the temperature of the mold assembly.

After the part 46 has solidified, the mold assembly 29 is opened, and the part 46 is removed.

In accordance with the present invention, the plastic melt 20 (and thus the resultant part) comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the plastic melt 20, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. In accordance with the method described above, a tubular formation in the form of parison 41 of the plastic melt is communicated to the mold assembly 29. The mold surfaces 43 correspond to a configuration of the part to be molded. Pressurized gas is applied through conduit or port 38 to an interior of the tubular formation 41 to expand the tubular formation into conformity with the mold surfaces 43. The

plastic melt when forced into conformity with surfaces 43 is then permitted to solidify (e.g, by cooling the mold assembly 29) to form the part 46. The solidified part is then removed from the mold assembly 29 and after the mold assembly 29 is opened.

The reinforcement filler particles, also referred to as "nanoparticles" due to the magnitude of their dimensions, each comprise one or more generally flat platelets. Each platelet has a thickness of between 0.7-1.2 nanometers. Generally, the average platelet thickness is approximately 1 nanometer thick. The aspect ratio (which is the largest dimension divided by the thickness) for each particle is about 50 to about 300.

The platelet particles or nanoparticles are derivable from larger layered mineral particles. Any layered mineral capable of being intercalated may be employed in the present invention. Layered silicate minerals are preferred. The layered silicate minerals that may be employed include natural and artificial minerals. Non-limiting examples of more preferred minerals include montmorillonite, vermiculite, hectorite, saponite, hydrotalcites, kanemite, sodium octosilicate, magadite, and kenyaite. Mixed Mg and Al hydroxides may also be used. Among the most preferred minerals is montmorillonite.

To exfoliate the larger mineral particles into their constituent layers, different methods may be employed. For example, swellable layered minerals, such as montmorillonite and saponite are known to intercalate water to expand the inter layer distance of the layered mineral, thereby facilitating exfoliation and dispersion of the layers uniformly in water. Dispersion of layers in water is aided by mixing with high shear. The mineral particles may also be exfoliated by a shearing process in which the mineral particles are impregnated with water, then frozen, and then dried. The freeze dried particles are then mixed into molten polymeric material and subjected to a high sheer mixing operation so as to peel individual

platelets from multi-platelet particles and thereby reduce the particle sizes to the desired range.

The plastic melt 20 utilized in accordance with the present invention are prepared by combining the platelet mineral with the desired polymer in the desired ratios. The components can be blended by general techniques known to those skilled in the art. For example, the components can be blended and then melted in mixers or extruders. Preferably, the plastic melt 20 is first manufactured into pellet form. Then pellets are then plasticized in the extruder 1 to form the plastic melt 20..

Additional specific preferred methods, for the purposes of the present invention, for forming a polymer composite having dispersed therein exfoliated layered particles are disclosed in U.S. Patent Nos. 5,717,000, 5,747,560, 5,698,624, and WO 93/11190, each of which is hereby incorporated by reference. For additional background, the following are also incorporated by reference: U.S. Patent Nos. 4,739,007 and 5,652,284

Preferably, the thermoplastic used for the purposes of the present invention is a polyolefin or a blend of polyolefins. The preferred polyolefin is at least one member selected from the group consisting of polypropylene, ethylene-propylene copolymers, thermoplastic olefins (TPOs), and thermoplastic polyolefin elastomers (TPEs).

The exfoliation of layered mineral particles into constituent layers need not be complete in order to achieve the objects of the present invention. The present invention contemplates that at least 50% of the particles should be less than about 20 nanometers in thickness and, thus, at least 50% of the particles should be less than about 20 platelets stacked upon one another in the thickness direction. In addition, at least 99% of the reinforcement particles should have a thickness of less than about 30 nanometers. With this extent of exfoliation, with a loading of less than 15% by volume, the benefits of the nanoparticles begin

to accrue with meaningful effect for many large thin part applications. For example, such loading of nanoparticles will provide a desired increase in the modulus of elasticity by about 50-70% over conventional fillers.

More preferably, at least 50 % of the particles should have a thickness of less than 10 nanometers. At this level, an additional increase of about 50-70% in the modulus of elasticity is achieved in comparison with the 50% of particles being less than 20 nanometer thick as discussed above. This provides a level of reinforcement and impact resistance that would be highly suitable for most motor vehicle bumper applications.

Preferably, at least 70% of the particles should have a thickness of less than 5 nanometers, which would achieve an additional 50-70% increase in the modulus of elasticity in comparison with the 50% of less than 10 nanometer thickness exfoliation discussed above. This provides ideal reinforcement and impact resistance for large thin parts that must withstand greater degrees of impart. It is always preferable for at least 99% of the particles to a thickness of less than about 30 nanometers (i.e., less than about 30 layers or platelets thick), as particles greater than this size act as stress concentrators..

It is most preferable to have as many particles as possible to be as small as possible, ideally including only a single platelet.

As noted above, the preferred aspect ratio (which is the largest dimension divided by the thickness) for each particle is about 50 to about 300. At least 80% of the particles should be within this range. If too many particles have an aspect ratio above 300, the material becomes too viscous for forming parts in an effective and efficient manner. If too many particles have an aspect ratio of smaller than 50, the particle reinforcements will not provide the desired reinforcement characteristics. More preferably, the aspect ratio for each particle is

between 100-200 . Most preferably, at least 90% of the particles have an aspect ratio within the 100-200 range.

Generally, in accordance with the present invention, the plastic melt 20 and hence the parts to be manufactured should contain less than 15% by volume of the reinforcement particles of the type contemplated herein. The balance of the part is to comprise an appropriate polyolefin material and suitable additives. If greater than 15% by volume of reinforcement filler is used, the viscosity of the composition becomes too high and thus difficult to mold.

Turning now to FIG. 4, there is shown a substantially hollow, integrally formed radiator and light support structure for a motor vehicle, generally indicated at 50, and manufactured in a blow molding operation in accordance with the present invention. The structure 50 is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the integrally formed radiator and light support structure 50, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. The structure 50 comprises a radiator frame portion 52, having apertures 54 for securing a motor vehicle radiator (not shown for sake of clarity) to the support structure 50. A pair of light receiving recesses 56 of the support structure 50 are constructed and arranged to mount headlights (not shown for sake of clarity) for the motor vehicle. The recesses 56 having apertures 58 for receiving electrical connecting portions of the lights.

As shown, the support structure can be nestingly received with respect to a motor vehicle fascia, indicated at 60.

Turning now to FIGS. 5 and 6. there is shown a hollow, sealed front end bumper, generally indicated at 70. The bumper 70 is shown mounted to the front end of a motor vehicle, generally indicated at 72. The hollow bumper comprises at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles have a thickness of less than about 30 nanometers. A fluid consuming component, such as a conventional windshield wiper fluid spraying assembly, generally indicated at 74 in FIG. 5, is constructed and arranged to be mounted on and used by the motor vehicle. A conduit 76 communicates the fluid consuming component with the sealed interior of the hollow bumper 70, thus permitting said hollow sealed bumper to serve as a fluid reservoir for the fluid consuming component (e.g., the wiper fluid spraying assembly 74).

The fluid consuming component to which the bumper 70 is communicated may be other components in the motor vehicle as well, such as the radiator 78, which may be communicated with the interior of the bumper 70 by conduit 80 (see FIG. 5).

It should also be appreciated that the bumper 70 may be divided so as to have two separate compartments. For example, in FIG. 6 it can be appreciated that the interior of bumper 70 is divided into compartments 84 and 86, with the compartment 84 communicating with the wiper spray assembly 74 via conduit 76, and the compartment 86 communicating with radiator 78 via conduit 80. Separate compartment filler necks 88 and 90 are provided for filling compartments 84 and 86, respectively, with the

appropriate fluids. Doors 92 and 94 are pivotally mounted close off access to necks 88 and 90, respectively, and to permit access to the necks when filling is desired.

Turning now to FIG. 7, there is shown a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, generally indicated at 100. The assembly 100 is formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material. The reinforcement particles comprise less than 15% of a total volume of the support structure assembly, at least 50% of the reinforcement particles have a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers. The integrally formed assembly includes i) a hollow radiator frame portion 102, and apertures 104 formed in the frame portion for securing a motor vehicle radiator (not shown for sake of clarity) to the frame portion 102, ii) a pair of light receiving recesses 106 constructed and arranged to mount lights (not shown for sake of clarity of illustration) for the motor vehicle. Apertures 108 are formed in the recesses 106 for connecting the lights with an electrical power source, and iii) a hollow bumper portion 110 constructed and arranged to be mounted to a front end of a motor vehicle.

By utilizing plastic melt with the loading of nanoparticles discussed above (e.g., less than 15% of a total volume of the plastic melt), higher modulus of elasticity of conventional large plastic parts can be achieved, and thus be manufactured with a reduced wall thickness while maintaining the same required impact resistance. In one example, the modulus of the material used to form a bumper is increased to between about 200,000 to about 500,000 PSI.

In accordance with the present invention, by adding the exfoliated platelet material in accordance with the above, the modulus of the large, thin part can be increased without significantly losing impact resistance. Because the modulus is increased, large thin parts,

such as bumpers, can be made thinner than what was otherwise possible. More specifically, bumpers for automobiles must have sufficient impact resistance or toughness to withstand various standard automotive impact tests.

For example, an automotive bumper must withstand a typical dart (puncture type) impact test wherein the bumper will not crack or permanently deform upon impact of at least 200 inch pounds force at a temperature of -30°C or lower. In a conventional IZOD impact test, it is desirable for the bumper to withstand at least 10 ft pounds/inch at room temperature and at least 5 ft pounds/inch at -30°C. In order to withstand cracking at such force levels, the modulus for the conventional bumper is typically between about 70,000 to about 150,000 pounds per square inch. (PSI). In accordance with the present invention, the modulus can be increased by a factor of 2 to 3 times, without significantly effecting the impact resistance.

In addition to the above mentioned benefits, use of the nanoparticle reinforced plastic melt enables the coefficient of linear thermal expansion to be reduced to less than 40 x10-6 inches of expansion per inch of material per degree Fahrenheit (IN/IN)/°F, which is less than 60% of what was previously achievable for thermoplastic motor vehicle bumpers that meet the required impact tests. As a further benefit, the surface toughness of the bumper can be improved. The improved surface toughness provided by the nanoparticles greatly reduces handling damage and part scrap. It also eliminates the need for the extra packaging and protective materials and the labor involved.

In addition, it is possible to double the modulus of polymers without significantly reducing toughness. Thus, it is possible to produce parts like bumpers using 20-35% thinner wall sections that will have comparable performance. The use of nanoparticles can provide the mechanical, thermal, and dimensional property enhancements, which are typically obtained by adding 20-50% by weight of glass fibers or mineral fillers or combinations

thereof to polymers. However, only a few percent of nanoparticles are required to obtain these property enhancements.

As a result of the fact that such low levels of nanoparticles are required to obtain the requisite mechanical properties, many of the typical negative effects of the high loadings of conventional reinforcements and fillers are avoided or significantly reduced. These advantages include: lower specific gravity for a given level of performance, better surface appearance, toughness close to that of the unreinforced base polymer, and reduced anisotropy in the molded parts.

It is preferable for these parts to have reinforcement particles of the type described herein comprising about 2-10% of the total volume of the panel, with the balance comprising the polyolefin substrate. It is even more preferable for these exterior panels to have reinforcement particles of the type contemplated herein comprising about 3%-5% of the total volume of the panel.

In accordance with another specific embodiment of the present invention, it is contemplated that the blow molding apparatus can be used to make large, highly reinforced parts having a modulus of elasticity of 1,000,000 or greater. Conventionally, these parts typically require loadings of 25-40% by volume of glass fiber reinforcement. This amount of glass fiber loading would result in a high viscosity of any melt pool that could be used in the blow molding apparatus of the present invention and would thus render the blow molding apparatus disclosed herein largely impractical for such application.

Use of the plastic melt 20 as described above enables the blow molding apparatus disclosed herein to manufacture large parts that can be provided with impact resistance characteristics that were not previously attainable. For example, the blow molding system of the present invention is able to manufacture large parts having a modulus of elasticity of

greater than 1,000,000 PSI by use of the plastic melt reinforced with loadings of 8-15% by volume of nanoparticles, with at least 70% of the nanoparticles having a thickness of 10 nanometers or less. As with the above described embodiment, the plastic melt used has substantially the same material composition as the part to be manufactured.

In this case of molding large parts with a modulus of elasticity greater than 1,000,000 PSI, it may be desirable to use engineering resins instead of polyolefins. Such engineering resins may include polycarbonate (PC), acrylonitrile butadiene styrene (ABS), a PC/ABS blend, polyethylene terephthalates (PET), polybutylene terephthalates (PBT), polyphenylene oxide (PPO), or the like. Generally, these materials in an unreinforced state have a modulus of elasticity of about 300,000 PSI – 350,000 PSI. At these higher loadings of nanoparticles (8-15% by volume), impact resistance will be decreased, but to a much lower extent than the addition of the conventional 25-40% by volume of glass fibers.

Although certain embodiments of the invention have been described and illustrated herein, it will be readily apparent to those of ordinary skill in the art that a number of modifications and substitutions can be made to the blow molding system disclosed and described herein without departing from the true spirit and scope of the invention.

What is claimed is:

1. A method for molding large parts, comprising the steps of:

providing a reinforced plastic melt comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the plastic melt, at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers;

communicating a tubular formation of said plastic melt to a mold assembly having a mold cavity defined by mold surfaces, said mold surfaces corresponding to a configuration of the part to be molded, an amount of said plastic melt communicated to said mold assembly being sufficient to form a part having a weight of at least 2 pounds and a total surface area of at least 400 sq. inches;

applying pressurized gas to an interior of said tubular formation to expand said tubular formation into conformity with said mold surfaces;

solidifying said plastic melt to form said part; and

removing said part from said mold assembly.

2. A method according to claim 1, wherein said part comprises a substantially hollow, integrally formed radiator and light support structure for a motor vehicle, said method including

forming a radiator frame portion of said support structure, and forming apertures in said frame portion for securing a motor vehicle radiator to said support structure,

forming a pair of light receiving recesses of said support structure constructed and arranged to mount lights for said motor vehicle, and forming apertures in said recesses for securing said lights to said support structure.

3. A method according to claim 2, wherein said lights comprise headlights.

4. A method according to claim 3, wherein said support structure further include another pair of recesses constructed and arranged to mount parking lights therein.

5. A method according to claim 2, wherein said forming of said apertures in said frame portion is accomplished after said part is removed from said mold assembly.

6. A method according to claim 2, wherein said forming of said apertures in said recesses is accomplished after said part is removed from said mold assembly.

7. A method according to claim 2, further comprising:

providing a front fascia for a motor vehicle;

nestingly disposing said support structure with respect to said front fascia.

8. A method according to claim 1, wherein said part comprises a substantially hollow,

bumper for a motor vehicle, said method further comprising:

mounting said bumper to an exterior of the motor vehicle at an end of the motor vehicle;

communicating and interior of said bumper to a fluid consuming component of the motor vehicle; and

filling said bumper with fluid to enable said bumper to serve as a fluid reservoir for said fluid consuming component.

9. A method according to claim 8, further comprising provided said bumper with a port for receiving said fluid.

10. A method according to claim 8, wherein said component comprises a windshield wiper fluid spraying assembly.

11. A method according to claim 10, wherein said component comprises a radiator.

12. A method according to claim 10, wherein said bumper comprises two compartments, wherein a first of said compartments is communicated with said windshield wiper spraying assembly, and wherein a second of said compartments is communicated with a radiator.

13. A method according to claim 1, wherein said part comprises a substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, said method including

forming a radiator frame portion of said integrally formed assembly, and forming apertures in said frame portion for securing a motor vehicle radiator to said support structure,

forming a pair of light receiving recesses of said integrally formed assembly constructed and arranged to mount lights for said motor vehicle, and forming apertures in said recesses for securing said lights to said support structure; and

forming a bumper portion of said integrally formed assembly; and

mounting said assembly on the front end of the motor vehicle.

14. In combination in a motor vehicle:

a hollow, sealed bumper constructed and arranged to be mounted on the motor vehicle, said hollow bumper comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the bumper, at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers;

a fluid consuming component constructed and arranged to be mounted on and used by the motor vehicle;

a conduit communicating said fluid consuming component with said hollow bumper, thus permitting said hollow sealed bumper to serve as a fluid reservoir for said fluid consuming component.

15. A substantially hollow, integrally formed bumper and radiator and light support structure assembly for a motor vehicle, and formed from at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the support structure assembly, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers; said integrally formed assembly including i) a hollow radiator frame portion, and apertures formed in said frame portion for securing a motor vehicle radiator to said frame portion, ii) a pair of light receiving recesses constructed and arranged to mount lights for said motor vehicle, and apertures formed in said recesses for connecting said lights with an electrical power source, and iii) a hollow bumper portion constructed and arranged to be mounted to a front end of a motor vehicle.

16. A substantially hollow, integrally formed radiator and light support structure for a motor vehicle, comprising a radiator frame portion of said support structure having apertures for securing a motor vehicle radiator to said support structure, and a pair of light receiving recesses of said support structure constructed and arranged to mount lights for said motor vehicle, said recesses having apertures for receiving electrical connecting portions of the lights, said integrally formed radiator and light support structure

comprising at least one thermoplastic material and reinforcement particles dispersed within the at least one thermoplastic material, the reinforcement particles comprising less than 15% of a total volume of the support structure, and at least 50% of the reinforcement particles having a thickness of less than about 20 nanometers, and at least 99% of the reinforcement particles having a thickness of less than about 30 nanometers.

Fig. 1

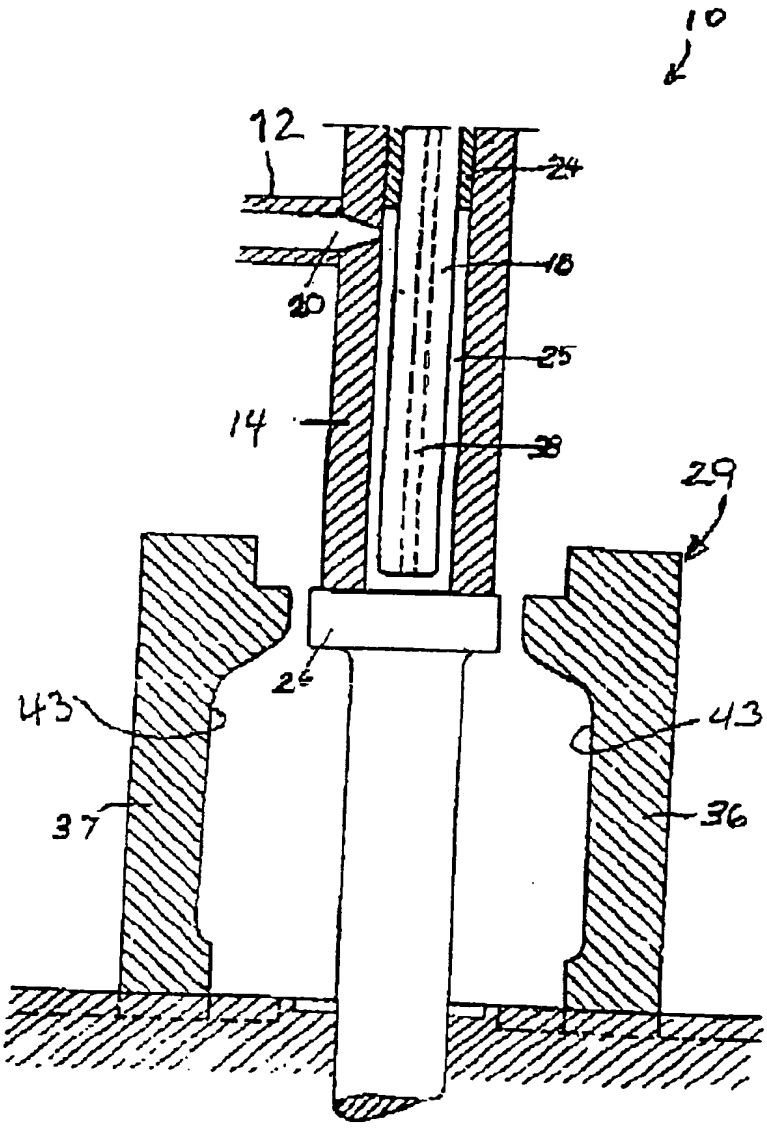


Fig. 2

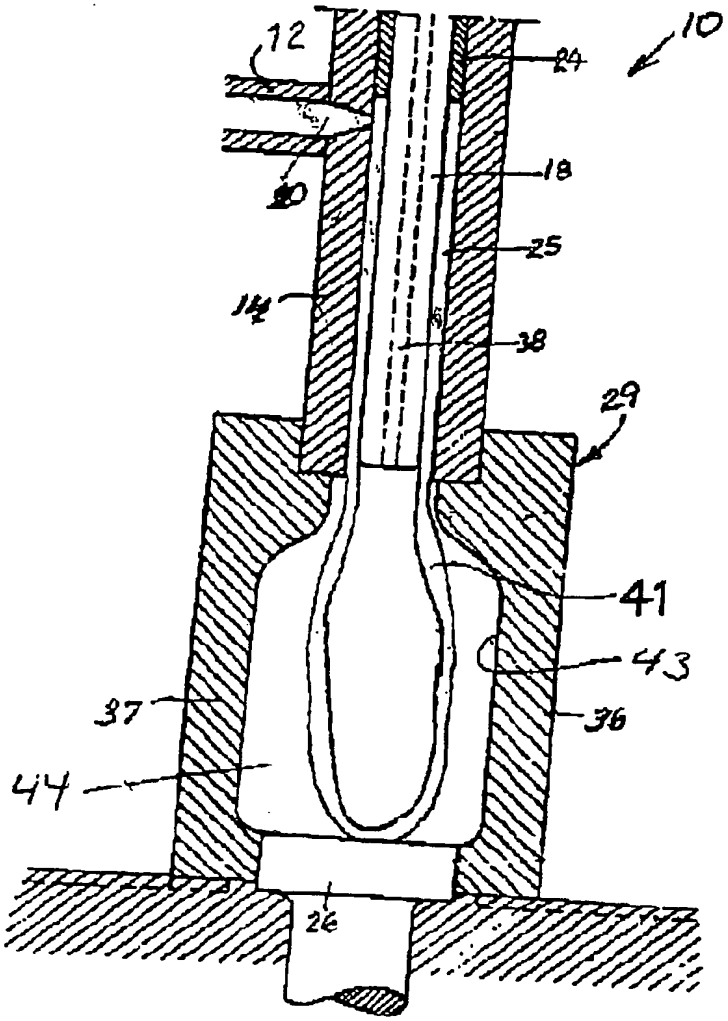
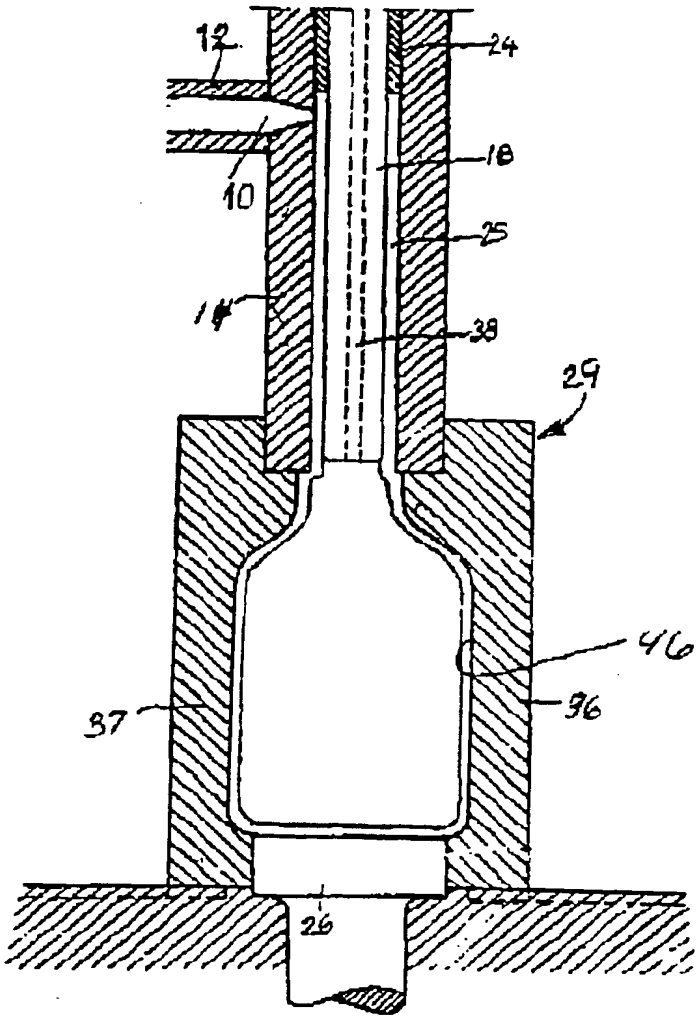


Fig. 3



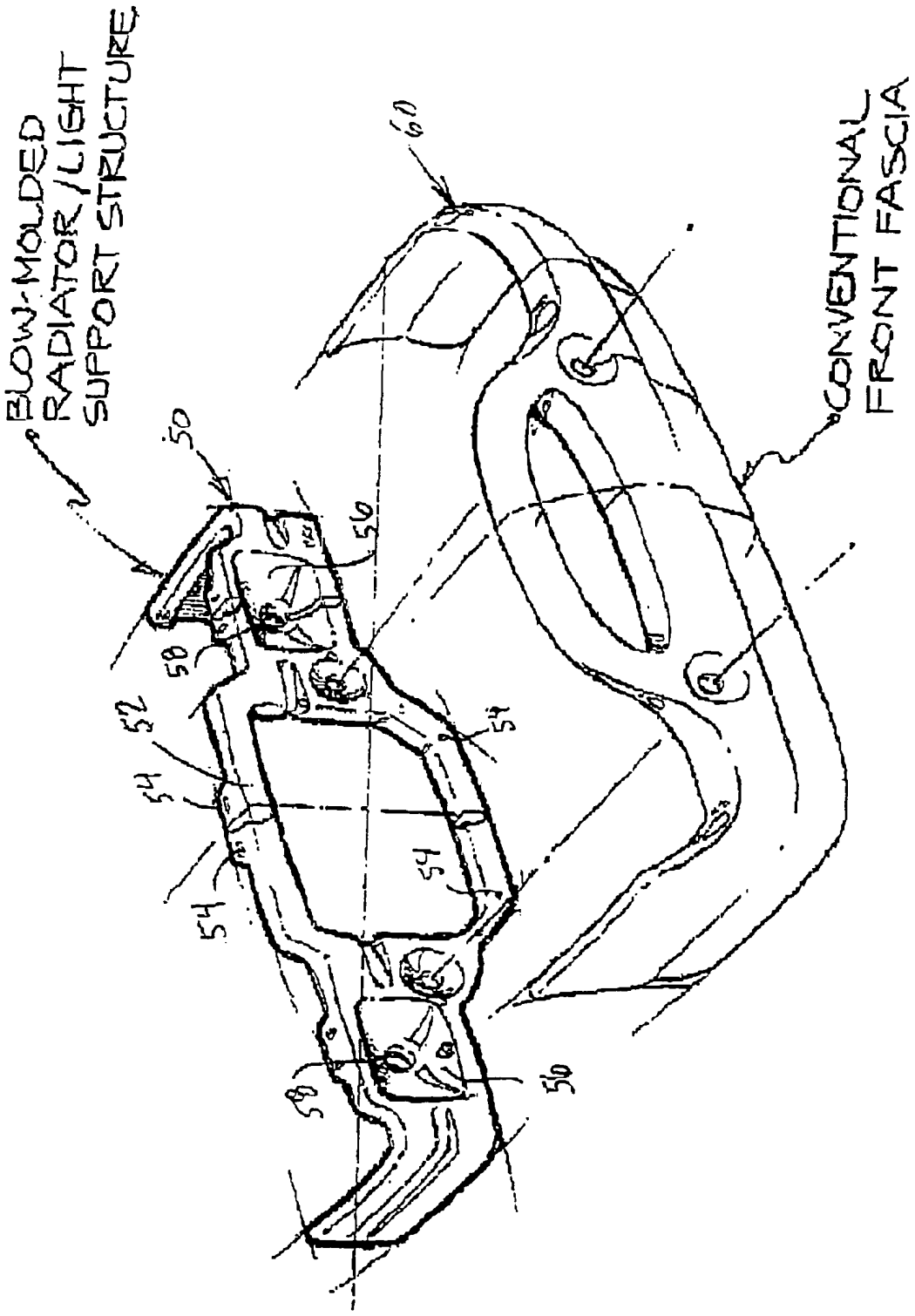

BLOW-MOLDED RADIATOR/LIGHT SUPPORT STRUCTURE
CONVENTIONAL FRONT FASCIA
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FIG. 4

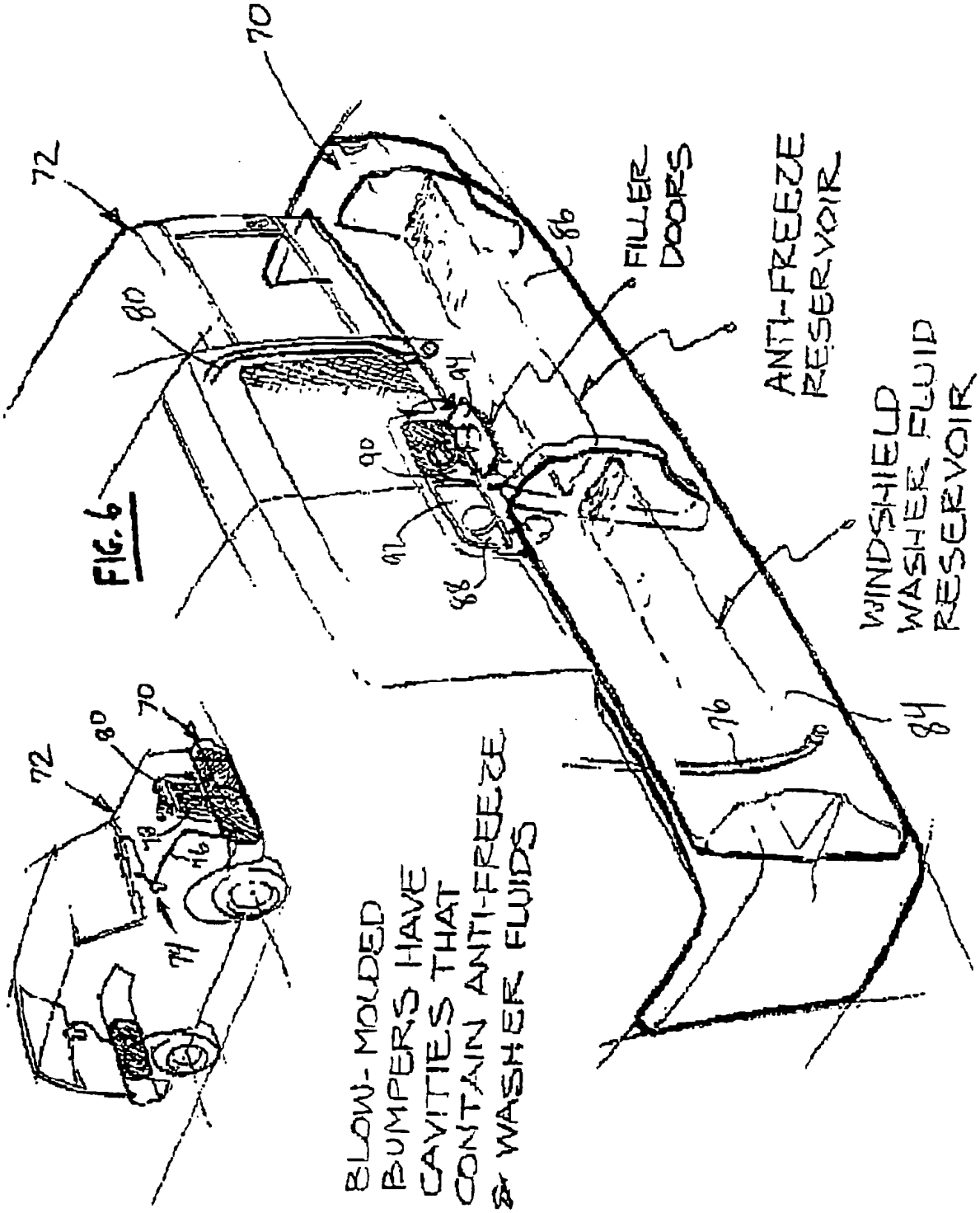
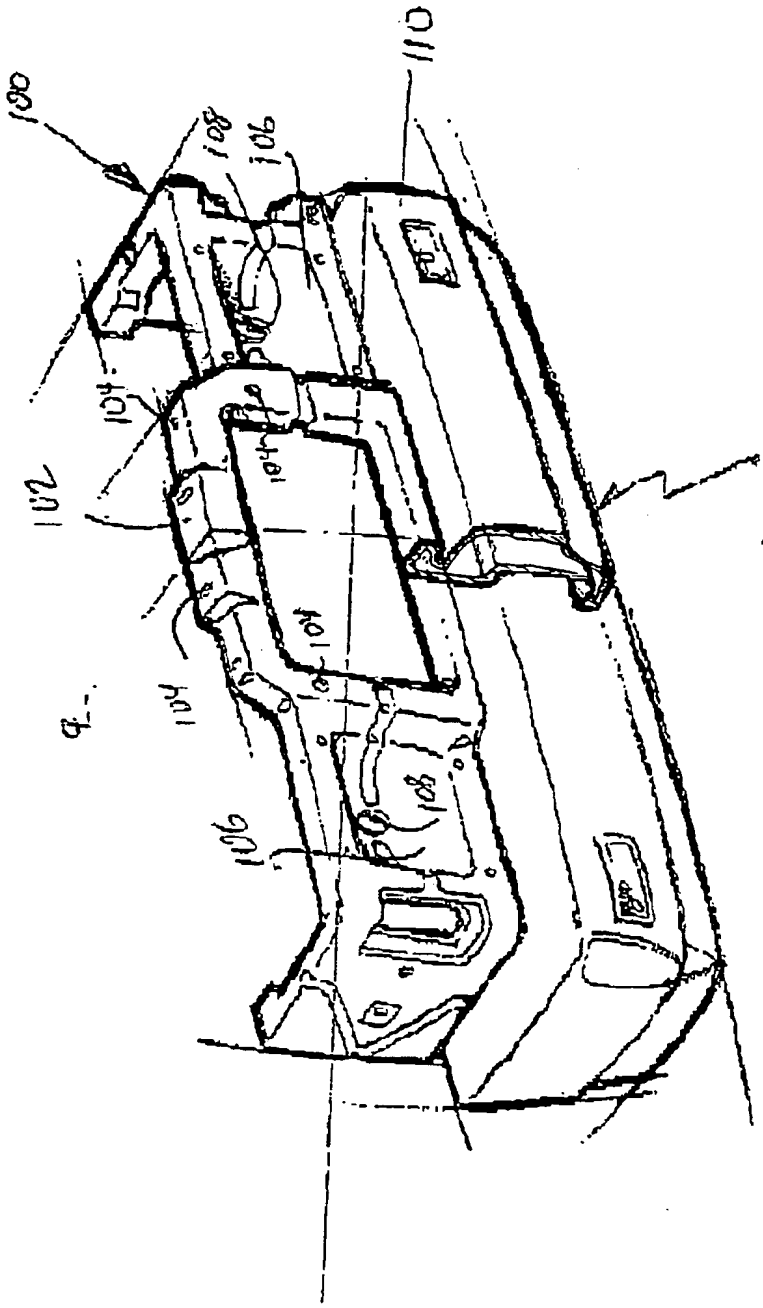

70
72
80
FILLER DOORS
ANTI-FREEZE RESERVOIR
WINDSHIELD WASHER FLUID RESERVOIR
84
76
BLOW-MOLDED BUMPERS HAVE CAVITIES THAT CONTAIN ANTI-FREEZE & WASHER FLUIDS

FIG. 6

FIG. 5

FIG. 7


100
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INTEGRAL BLOW-MOLDED BUMPER, RADIATOR & LIGHTING SUPPORT STRUCTURE

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/29991

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C49/04 B60R19/48 B60R19/03 B60K11/04 B62D21/16
B62D25/08 B60S1/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C B60R B60K B62D B65D B60S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 2, line 6 - line 10; claims 1-3,9 page 3, line 7, paragraph 11 page 3, line 47 - line 50 page 4, line 11 - line 16	2,8,13
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A	EP 0 747 451 A (AMCOL INTERNATIONAL CORP) 11 December 1996 (1996-12-11) page 18, line 37 -page 19, line 2	1,14-16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2000	18/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Kosicki, T

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

[redacted] al Application No
PCT/US 99/29991

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* MAGNA376PCT1

Box No. I TITLE OF INVENTION

METHOD AND APPARATUS FOR BLOW MOLDING LARGE REINFORCED PLASTIC PARTS

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

MAGNA INTERNATIONAL OF AMERICA, INC.
600 Wilshire Drive
Troy Michigan 48084
United States of America

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

WILSON, Phillip S.
5480 Huron Hillsl Drive
Commerce Township, Michigan 48382
United States of America

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BARUFKA, Jack S.
PILLSBURY MADISON & SUTRO LLP
1100 New York Avenue, N.W.
Washington, D.C. 20005
United States of America

Telephone No. 202 861 3000

Facsimile No. 202 822 0944

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked):*

Regional Patent

☒ **AP ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Cote d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line):*

☒ AE United Arab Emirates
☒ AL Albania
☒ AM Armenia
☒ AT Austria
☒ AU Australia
☒ AZ Azerbaijan
☒ BA Bosnia and Herzegovina
☒ BB Barbados
☒ BG Bulgaria
☒ BR Brazil
☒ BY Belarus
☒ CA Canada
☒ CH and LI Switzerland and Liechtenstein
☒ CN China
☒ CU Cuba
☒ CZ Czech Republic
☒ DE Germany
☒ DK Denmark
☒ EE Estonia
☒ ES Spain
☒ FI Finland
☒ GB United Kingdom
☒ GD Grenada
☒ GE Georgia
☒ GH Ghana
☒ GM Gambia
☒ HR Croatia
☒ HU Hungary
☒ ID Indonesia
☒ IL Israel
☒ IN India
☒ IS Iceland
☒ JP Japan
☒ KE Kenya
☒ KG Kyrgyzstan
☒ KP Democratic People's Republic of Korea
☒ KR Republic of Korea
☒ KZ Kazakhstan
☒ LC Saint Lucia
☒ LK Sri Lanka
☒ LR Liberia
☒ LS Lesotho
☒ LT Lithuania
☒ LU Luxembourg
☒ LV Latvia
☒ MD Republic of Moldova
☒ MG Madagascar
☒ MK The former Yugoslav Republic of Macedonia
☒ MN Mongolia
☒ MW Malawi
☒ MX Mexico
☒ NO Norway
☒ NZ New Zealand
☒ PL Poland
☒ PT Portugal
☒ RO Romania
☒ RU Russian Federation
☒ SD Sudan
☒ SE Sweden
☒ SG Singapore
☒ SI Slovenia
☒ SK Slovakia
☒ SL Sierra Leone
☒ TJ Tajikistan
☒ TM Turkmenistan
☒ TR Turkey
☒ TT Trinidad and Tobago
☒ UA Ukraine
☒ UG Uganda
☒ US United States of America
continuation
☒ UZ Uzbekistan
☒ VN Viet Nam
☒ YU Yugoslavia
☒ ZA South Africa
☒ ZW Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

☒ CR Costa Rica ☒ TZ United Republic of Tanzania
☒ DM Dominica ☒ MA Morocco

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Supplemental Box *If the Supplemental Box is not used, this sheet need not be included in the request.*

*1. If, in any of the Boxes, **the space is insufficient** to furnish all the information: in such case, write "Continuation of Box No. ..." [indicate the number of the Box] and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*

*(i) **if more than two persons are involved as applicants and/or inventors** and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

*(ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication **"the States indicated in the Supplemental Box"** is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

*(iii) if, in Box No. II or in any of the sub-boxes of Box No. III, **the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America:** in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

*(iv) if, in addition to the agent(s) indicated in Box IV, there are **further agents**: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

*(v) if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication **"patent of addition,"** or **"certificate of addition,"** or if, in Box No. V., the name of the United States of America is accompanied by an indication **"continuation"** or **"continuation-in-part"**: in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI) , the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;*

*(vi) if, in Box No. VI, there are **more than three earlier applications whose priority is claimed:** in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI;*

*(vii) if, in Box No. VI, the **earlier application is an ARIPO application:** in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.*

*2. If, with regard to the **precautionary designation statement** contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.*

*3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning **non-prejudicial disclosures or exceptions to lack of novelty**: in such case, write "Statement concerning non-prejudical disclosures or exceptions to lack of novelty" and furnish that statement below.*

Box No. iV. Agent or Common Representative: (continued)

KOKULIS, Paul N.	BIRD, Donald J.	EDGELL, G. Paul
LIPPITT, Raymond F.	ECCLESTON, Lynn E.	JAKOPIN, David A.
KNIGHT, G. Lloyd	GOWDEY Peter W.	PAULSON, Mark G.
LOVE, Carl G.	LAZAR, Dale S.	KLIMA, Timothy J.
MARTIN, Edgar H.	PERRY, Glenn J.	McQUADE, Paul F.
COLTON, Kendrew H.	MORDUCH, Ruth N.	DZWONCZYK, Michael R
JOYCE, Kevin E.	WHITE, Paul E., Jr.	SIRILLA, George M.
WISE, Roger R.	BENGTSSON, W. Patrick	
ZAITLEN, Richard H.	SMYRSKI, Steven W	KIRKPATRICK, Anita M.
HESS, Adam R.	GLAZIER, Stephen C.	
FINKELSTEIN, Jay M.	NAGY, Paul G.	

All attorneys are partners of the firm of PILLSBURY MADISON & SUTRO, LLP. The address, telephone number, and facsimile number of all the above attorneys are as indicated in Box IV.

Box No. V Designation of States (continued)

US: 60/113,064 filed 21 Dec 1998 (21.12.98)

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 21 December 1998 (21.12.98)	60/113,064	US		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ EP

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country (or regional Office)

Box No. VIII CHECK LIST: LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	:	4
description (excluding sequence listing part)	:	15
claims	:	6
abstract	:	1
drawings	:	6
sequence listing part of description	:	
Total number of sheets	:	32

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as items(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify):* Transmittal Fee to US/RO and return post card

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: ENGLISH

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Jack S. Barufka

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/
6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: **MAGNA376PCT1**

Applicant: **MAGNA INTERNATIONAL OF AMERICA, INC.**

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . **240.00** T

2. SEARCH FEE . . . . . **1,002.00** S

International search to be carried out by **EP**

(If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

Basic Fee

The international application contains **32** sheets.

first 30 sheets . . . . . **455.00** b_1

2 remaining sheets x **$10.00** additional amount = **20.00** b_2

Add amounts entered at b_1 and b_2 and enter total at B . . **475.00** B

Designation Fees

The international application contains **all** designations.

10 number of designation fees payable *(maximum 10)* x **105.00** amount of designation fee = **1,050.00** D

Add amounts entered at B and D and enter total at I . . . . . **1,525.00** I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . **15.00** P

5. TOTAL FEES PAYABLE

Add amounts entered at T, S, I and P, and enter total in the TOTAL box: **2,782.00** TOTAL

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

☒ authorization to charge deposit account (see below)	☐ bank draft	☐ coupons
☒ cheque	☐ cash	☐ other *(specify):*
☐ postal money order	☐ revenue stamps	

DEPOSIT ACCOUNT AUTHORIZATION *(this mode of payment may not be available at all receiving Offices)*

The RO/ **US**

☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☒ *(this check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

Deposit Account Number	Date *(day/month/year)*	Signature
03-3975	17 December 1999	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
MAGNA 376PCT 1		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/29991	17/12/1999	21/12/1998
International Patent Classification (IPC) or national classification and IPC B29C49/04		
Applicant MAGNA INTERNATIONAL OF AMERICA, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/07/2000	30.01.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Dorfschmidt, E Telephone No. +49 89 2399 2915

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/29991

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-15 as originally filed

Claims, No.:

1-16 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-16
	No:	Claims	
Inventive step (IS)	Yes:	Claims	2-16
	No:	Claims	1
Industrial applicability (IA)	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The documents, listed in the Search Report, do not disclose large molded parts according to the subject-matter of independent claims 14 to 16. Nowhere could be found a hint to the specific constructional details of such articles.

2. Therefore, the subject-matter of claims 14 to 16 seems to fulfil the requirements of Article 33 PCT with respect to novelty and inventive step.

3. Considering the subject-matter of claim 1 and the disclosure of US-A-3466701 (D1, known by the examiner's own knowledge) it is to be noted that D1 already describes the claimed **process** steps like providing a thermoplastic, communicating a tubular preform, applying pressurized gas, solidifying the melt and removing the article from the mold, see, e.g. Figures 1 to 8 with the description relating thereto. The specific used resin with respect to the nanoparticles is in this context of no importance, because there are not claimed specific process steps related to these particles.

   The use of nanoparticles in such extruded articles are generally known, see, e.g. EP-A-0810260 (D2) the description page 2, line 35 to page 3, line 50. Therefore, the subject-matter of claim 1 seems not to fulfil the requirements of Article 33 PCT with respect to inventive step.

4. If, however, present claims 14 to 16, directed to the article itself, are renumbered as claims 1 to 3 (when entering into the national phase), and if present 'method' claim 1 is renumbered as claim 4 and referred to the 'article' claims, then there could not be made any objections against this 'method' claim.

5. The dependent claims are concerned with further details of the invention and seem likewise to be novel and inventive.

Re Item VII
Certain defects in the international application

1. In contradiction with the requirements of Rule 6.3(b)(i) and (ii) PCT, the independent claims have not been cast in the two part form, with those features which in combination are part of the prior art being placed in the preamble.

2. The technical features mentioned in the claims are not followed by reference characters relating to these features, contrary to Rule 6.2(b) of the PCT. This applies to both the preamble and characterising portion.

3. A document reflecting the prior art described on page 1, is not identified in the description (Rule 5.1(a)(ii) PCT).

4. Documents D1 and D2 have not been identified in the description nor has the relevant background art disclosed therein been discussed. The requirements of Rule 5.1 (a)(ii) PCT are, thus, not fulfilled.

5. Figures 4 to 7 do not fulfill the requirements of Rule 11,13 PCT with respect to the text terms in the drawings.

Re Item VIII
Certain observations on the international application

The units of weight/area/pressure employed in, e.g. claim 1 and on pages 1, 6, 12, 13, etc. are not additionally expressed in terms of the units stipulated by Rule 10.1/(a)/and/(b) PCT.